R-3825-5
VOLUME I

TECHNICAL MANUAL

MAINTENANCE AND REPAIR

J-2 ROCKET ENGINE
GROUND SUPPORT EQUIPMENT

(ROCKETDYNE)

CHANGE -NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

NOTICE: INSTRUCTIONS FOR THE USE OF THE GROUND SUPPORT EQUIPMENT COVERED HEREIN CAN BE FOUND IN TECHNICAL MANUAL R-3825-1B OR R-3825-3.

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LIST OF EFFECTIVE PAGES

NOTE The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page

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Upon receipt of the second and subsequent changes to this technical manual, personnel responsible for maintaining this publication in current status will ascertain that all previous changes have been received and incorporated. Actions should be taken promptly if the publication is incomplete.

This page reflects the current status of the complete manual. All pages listed must be in the manual to make this publication current and complete.

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PREFACE

The information on this page modifies data appearing on pages throughout the manual. The specific pages on which the data appears will be changed when the pages are changed for other technical reasons. When all pages have been changed, this Preface will be deleted.

References in this manual to information in R-3825-11 should be made to R-3825-1B.

Whenever gaseous nitrogen is specified in this manual for drying, air that meets the cleanness level and inspection requirements of MSFC-PROC-404 may be used.

INTRODUCTION

This manual is one of the R-3825-series technical manuals prepared to provide official Rocketdyne field support documentation for the operation and maintenance of the J-2 Rocket Engine, Part Number 103826, Serial Numbers J-2046, J-2056, J-2062, J-2083, J-2087, J-2095, J-2103, J-2104, J-2107, J-2126 through J-2130, J-2132, J-2135 through J-2147, and J-2149 through J-2152, and its related ground support equipment, designed and manufactured by Rocketdyne Division, Rockwell International, 6633 Canoga Avenue, Canoga Park, California 91304. The information in these manuals was prepared by Logistics Product Support Department of Rocketdyne.

The manuals are used to best advantage when each manual is current and complete (see figure 1) and the purpose and scope of each manual is known. The manuals in this series, and the nature of the data each provides, are found in the contents and support function chart.

1. J-2 MANUALS--THEIR SUPPORT FUNCTIONS.

The contents and support function chart lists all J-2 series technical manuals, describes the support function of each manual, and lists the section titles of each manual. The chart also explains how the technical data in each manual relates to the support of the engine and its ground support equipment throughout a normal engine flow, as well as during unscheduled maintenance tasks. Information appearing in one manual is not duplicated in another. Thus, information on the description, operation, and maintenance of ground support equipment is in R-3825-5. However, the instructions for servicing the engine using ground support equipment are in R-3825-3 and R-3825-1B.

Manual	Contents and Support Function	Section and Title
R-3825-1 J-2 Rocket Engine Data	This manual contains a description and theory of operation of the engine, its systems, and its components; mass properties and design load criteria, including engine weight, gimbaled mass, center of gravity, and moment of inertia for the basic engine and its accessories; and customer connections. The manual serves to familiarize the reader with the design and operation of the J-2 engine and serves as a training aid document.	I Description and Operation II Deleted through VII VIII Performance IX Mass Properties and Design Load Criteria X Electrical System Interface Data XI Instrumentation System Interface Data XII Customer Connections
R-3825-1B J-2 Rocket Engine Operating Instructions Supplement	This manual contains authorized field operating requirements that affect flight engines during their normal flow from engine receipt through vehicle launch, and those procedures recommended by Rocketdyne that support these requirements most effectively. All	I Operating Requirements II General Requirements III Operating Procedures

Manual	Contents and Support Function	Section and Title
R-3825-1B (cont)	specific and general requirements for activities to be performed and acceptability criteria for these activities are included along with the limits, special constraints, safety precautions, and correct sequences required to satisfactorily accomplish the activities.	
R-3825-3, Volume I J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for handling; component removal and installation; cleaning; post-maintenance test requirements; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	I General Maintenance and Repair II Handling III Component Removal and Installation IV Post-Maintenance Test Requirements V Preparation of Components Handler Equipment for Use VI In-Place Tube Welding
R-3825-3, Volume II J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for component bench testing and repair; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	I Air Filler Valve II Armored Harness III Augmented and Gas Generator Spark Igniter Cables IV Electrical Control Assembly V Flight Instrumentation Packages VI Fuel Turbopump VII Heat Exchanger VIII Helium Fill Check Valve IX Ignition Detector Probe X Insulation XI Integral Hydrogen-Helium Start Tank XII Mainstage OK Pressure Switch XIII Oxidizer Turbopump XIV Purge and Seal Drain Check Valves XV Solenoid Valves XVI Start Tank Discharge Valve XVII Start Tank Refill Check Valve Manifold 307599-41 XVIII Start Tank Support and Fill Valve XIX Thrust Chamber XX Transducers XXI Vent Port Check Valves

Manual	Contents and Support Function	Section and Title	
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		XXI	Start Tank Discharge Valve
		XXII	Fuel Jacket Purge Check Valve
		XXIII	Oxidizer Turbopump
		XXIV	Propellant Utilization Valve
		XXV	Flight Instrumentation Packages
		XXVI	Spark Igniter Cables
		XXVII	Thrust Chamber Exit Closure
R-3825-4 J-2 Rocket Engine Illustrated Parts Breakdown	This manual contains related illustrations and columnar listings of all parts of the engine that can be replaced at field sites as determined by the maintenance concept; definitions and designations of source, maintenance, repairability, interchangeability, and usable on codes; information pertaining to retrofit modifications; identification of next-higher assemblies; and identification of reference designation numbers.	I	Introduction
		II	Group Assembly Parts List
		III	Numerical Index
R-3825-5, Volume I J-2 Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	See table of contents for this volume.	
R-3825-5, Volume II J-2 Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	I	Miscellaneous Tools
		II	Gas Generator High-Low Temperature Cutoff Panel G1047
		III	Outboard Engine Restrainer G4066
		IV	Film-Cooled Diffuser G4070
		V	Components Adapter Set 9016796
		VI	Liquid Nitrogen Service Unit 2425000
		VII	Electrical Interface Support 9024460
		VIII	Spark Monitor/Overspeed Cutoff Panel G1045
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Manual	Contents and Support Function	Section and Title
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	XV	Amplifier Mounting Panel 9024500
	XVI	Thrust Chamber Diffuser Installing Tool Kit 9025144
	XVII	Proof-Test Weights
	XVIII	Engine Handling Slings
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	XX	Propellant Inlet Duct Null Adjuster Set 9024540
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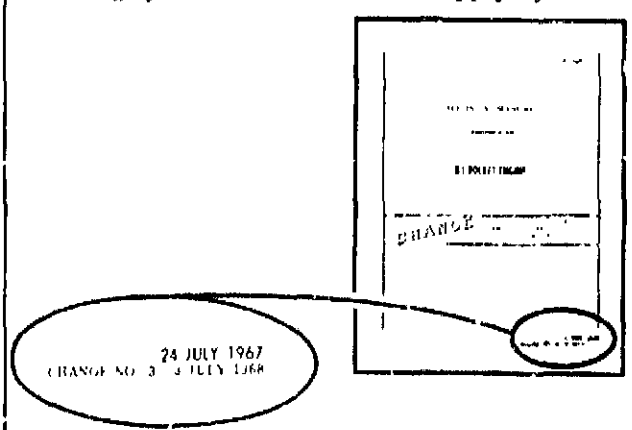
	XXXIII	Engine Components Installers

USE YOUR MANUAL ONLY IF CURRENT AND COMPLETE

Manuals that are not current and complete are not authoritative documents and are not to be used. The following outlines the method for determining whether your manual is current and complete.

A. DETERMINING CURRENCY. To be sure that yours is the latest issue of the manual, refer to Configuration Identification & Status Report , which is revised monthly and lists the technical manual numbers, titles, unincorporated supplements, and latest change or revision dates. Your manual must have a title page with the same or later date than the date shown in the Configuration Identification & Status Report. Your manual must also include the unincorporated supplements listed in the Configuration Identification & Status Report, or if your manual is later than shown in the report, the unincorporated supplements listed in the Manual Data Supplement Record in your manual. If your title page incorporates two dates as illustrated below, compare the change (lower) date. If your manual is not current, obtain a current copy through your technical manual supply system.

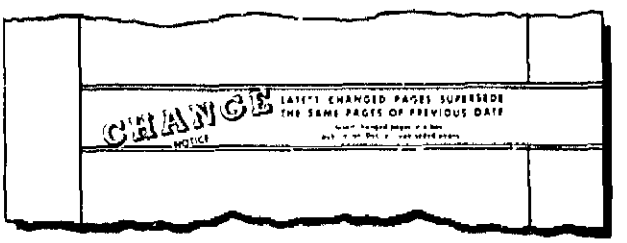


B. DETERMINING COMPLETENESS. To be sure that your manual is complete, make a page-by-page comparison of its pages to those listed in the List of Effective Pages. The List of Effective Pages, which shows the change status since the basic issue or last revision, is found on the alphabetically lettered page(s) immediately following the title page. All pages, except supplements, are listed with their issue dates. Manual pages that are dated must have the same date as that appearing in the List of Effective Pages for that page. Unchanged pages are listed as "original" and are not dated.

HOW TO KEEP YOUR MANUAL UP-TO-DATE

As design changes are made to the rocket engine and ground support equipment and better methods of maintenance are discovered, your manual is periodically changed, revised, or supplemented. The following steps will help you keep your manual up-to-date:

A. CHANGES. Updating by adding to or partially replacing existing pages is defined as a change. Changes can be identified by the change notice on the new title page.



To collate a change, refer to the Filing Instructions sheet issued with the manual and proceed as follows:

1. Remove the pages listed in the "Remove" column of the Filing Instructions sheet from the manual and destroy them. Do not concern yourself with the data on the opposite side of the deleted page since, if this date is not deleted, it is replaced in the change package.

2. Insert all pages listed in the "Insert" column of the Filing Instructions sheet in sequence. Pages with a suffix letter are inserted in alphabetical order following the page with the same basic number; for example, pages 3-14A, 3-14B, etc, follow page 3-14.

GEN-NASA-1A

Figure 1. How to Maintain Your Manual (Sheet 1 of 2)

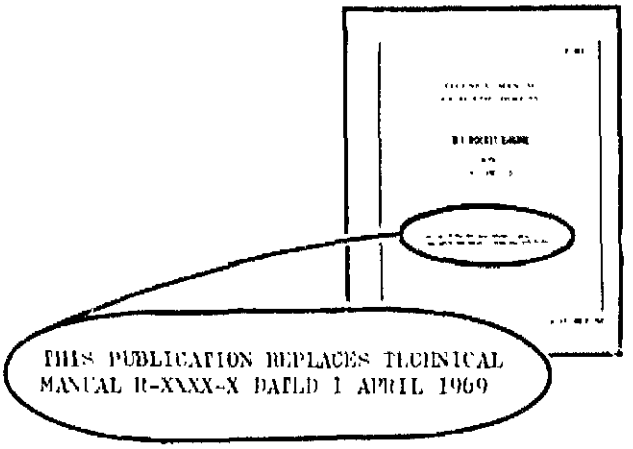
3. If you are unsure of the status of any page or pages, refer to the List of Effective Pages and make sure your manual contains pages (with the corresponding change dates) listed in the List of Effective Pages.

4. Remove manual supplements that have been incorporated.

NOTE

Incorporated supplements can be determined by reviewing the newly issued Manual Data Supplement Record.

B. REVISIONS. Updating by replacing all the existing pages of a manual is defined as a revision. Revisions can be identified by the replacement notice on the new title page.



To collate a revision, proceed as follows:

1. Remove and destroy all existing pages of your manual except Manual Data Supplements that have not been incorporated.

NOTE

Unincorporated supplements can be identified by reviewing the Manual Data Supplement Record supplied in the revision.

2. Insert the new pages in your cover.

C. SUPPLEMENTS. Updating that authorizes the addition to, or alteration of, the existing data in your manual is defined as a Manual Data Supplement. Information on how to insert supplements is found in the supplements.

HOW TO KEEP ABREAST OF THE LATEST CHANGES TO TECHNICAL DATA

Changes and/or additions to technical data are identified by a vertical bar (change bar) in the margin of the page adjacent to the changed data. A direct comparison between the new (identified by the change bar) and the old data will help you in identifying specific changes made.

GEN-NASA-2

Figure 1. How to Maintain Your Manual (Sheet 2 of 2)

2. CONFIGURATION IDENTIFICATION.

EQUIPMENT CONFIGURATION. The MD identification symbol and the equipment model designation indicate the configuration of the equipment and distinguish it from models incorporating different changes and from basic models. A basic, unchanged configuration of the equipment has no MD identification symbol. MD identification symbols are added as changes affecting configuration are incorporated into the equipment. The MD identification symbol is stamped on the MD plate, which is mounted near the equipment nameplate.

MD IDENTIFICATION SYMBOLS. The MD identification symbol is a composite number representing all the changes affecting configuration (MD changes) that are incorporated or not incorporated into the equipment. The symbol represents a consecutively numbered series of MD changes. Any MD change, or series of MD changes, not incorporated is represented by an "X." Multi-digit numbers are underlined. Two figures together represent the limits of a series of incorporated MD changes. Figure 2 illustrates how MD changes incorporated in the equipment are represented by the MD identification symbol.

MANUAL REFERENCE. A reference that appears in the manual may refer to a series of MD changes or to an individual MD change; for example, "MD9" refers to MD1 through MD9, but "MD9 change" refer to the individual MD change 9. This latter type of reference, which is illustrated in figure 2, identifies separate sets of information required by differences in configuration. When an MD reference appears in this manual, examine the MD identification symbol on the equipment to determine which set of information is applicable.

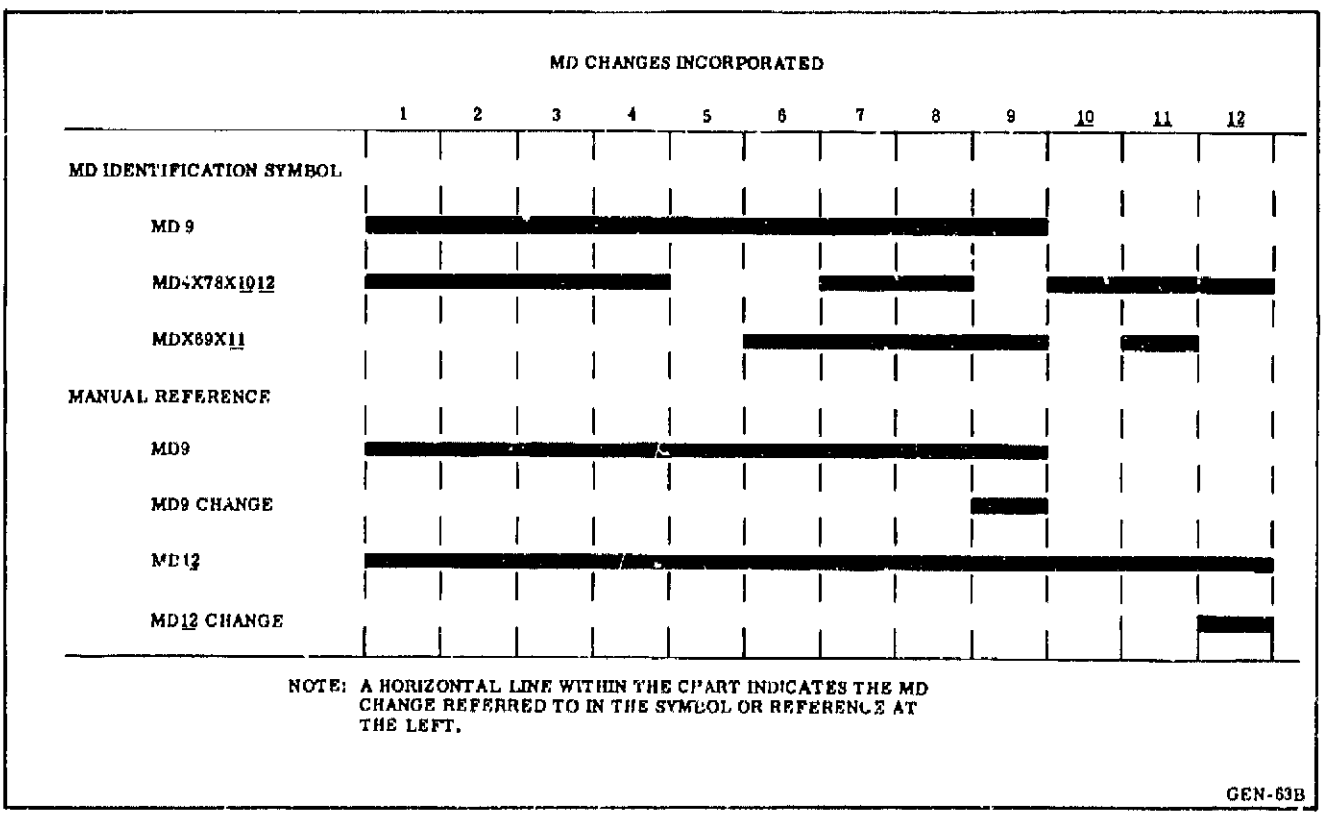


Figure 2. MD System

3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

All approved ECPs (Engineering Change Proposals) applicable to the equipment covered in this volume are listed in the Configuration Change--Manual Effectivity figure of the applicable section when the ECP is incorporated in the manual. This figure includes the associated MD or part dash number and the publication date of the volume in which the ECP was incorporated. Should an approved ECP not affect the data, N/A is entered in the publication date column. GSE configuration information and GSE serial number allocation are in R-5788, Saturn J-2 Configuration Identification & Status Report.

4. DATA BASIS.

This volume provides the data needed to acquaint the user with the hardware and to enable him to perform the maintenance tasks dictated by the needs of the hardware and recommended for field performance by the maintenance concept reflected in R-8842, Maintenance and Support Plan for Saturn F-1, H-1, and J-2 Rocket Engines. Specific references to the related manual containing the operational data are made in the applicable sections. Planned maintenance requirement data is not intended to limit the level of repair of vendor hardware when such repair or minor part replacement can correct the defect, has no detrimental effect on the safety or performance of the end item and its components, and has the concurrence of Rocketdyne Engineering.

SECTION I

GENERAL MAINTENANCE AND REPAIR

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Underlined titles denote primary paragraphs.

1-1. SCOPE. This section contains general maintenance and repair information that is applicable to several sections of this manual. Suggested methods of accomplishing tasks are included in this section. Other methods may be used providing they achieve the same results.

1-2. SAFETY PRECAUTIONS.

NOTE

When performing work specified in this manual, all local safety and health directives must be complied with. It is assumed these directives are in compliance with the Occupational and Safety Health Act. When local safety and health directives are more stringent than those specified in this manual, the local directives will prevail.

1-3. Warnings and cautions are used throughout the text to indicate potentially dangerous steps. These warnings and cautions precede the step to which they apply and must be strictly observed by personnel performing the procedures. Specific precautions to follow are listed when a task involves working with potentially dangerous materials or hazardous conditions. The following examples explain warnings and cautions:

WARNING

A warning indicates a procedure or practice that, if not followed correctly, can cause injury or death.

CAUTION

A caution indicates a procedure or practice that, if not followed correctly, can cause damage to equipment.

1-4. ELECTRICAL SYSTEMS.

1-5. Observe the following safety precautions when working with electrical systems:

WARNING

Connecting or disconnecting electrical connectors without turning off electrical power can result in injury to personnel and damage to equipment.

a. Make sure electrical power is off before working on electrical components or cables.

b. Make sure facility outlet and control switch or circuit breaker on electrical equipment are deenergized before connecting power source to electrical equipment.

c. Do not leave controls unattended when an electrical system is energized.

d. Ground all equipment to a common ground point, where required.

1-6. PRESSURIZED SYSTEMS.

1-7. Observe the following safety precautions when working with high-pressure systems:

WARNING

Removing fittings, parts, or components from a pressurized system can result in injury to personnel and damage to equipment.

a. Make sure system is depressurized before disconnecting test equipment lines or hoses and before tightening or loosening any fitting.

b. Do not leave controls unattended while system is pressurized.

c. Secure all test hoses connected between test equipment, facility, or component under test, to prevent whipping if accidentally disconnected or in event of line failure.

d. Wear safety glasses or face shield when working on a pressurized system.

e. Make sure connections on all system components are secure.

f. Follow specified requirements for gasket sealants and lubricants.

1-8. CLEANING SOLVENTS.

1-9. Although cleaning solvents specified are considered the least hazardous of solvents available, specific uses of each solvent require special precautions, as stated in each applicable procedure. Improper use of a solvent can cause injury to personnel or damage to equipment.

1-10. TRICHLOROETHYLENE AND TRICHLOROETHANE. Trichloroethylene and trichloroethane are toxic solvents that are nonexplosive and, under usual conditions of use, nonflammable. These solvents decompose at temperatures above 248° F, releasing toxic products. Observe the following safety precautions when using trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or trichloroethane ST0210GB0002 (NR, Los Angeles Division):

a. Wear breathing apparatus when using these solvents in confined or unventilated areas. Inhalation of concentrations exceeding 100 ppm of trichloroethylene (350 ppm of trichloroethane) for prolonged periods of time may result in narcosis or unconsciousness. Indications of excessive inhalation exposure are headache, blurring of vision, giddiness, nausea, or vomiting. These effects are completely reversible upon removal of the individual to a well-ventilated area.

b. Do not allow these solvents to contact skin for prolonged periods, as they defat the skin, leaving it susceptible to infection and cracking.

c. Wear safety glasses or a face shield when using these solvents.

1-11. CLEANING COMPOUND. Observe the following safety precautions when using cleaning compound (MIL-C-81302):

a. Avoid inhalation of vapors of cleaning compound since it may cause headaches, dizziness, sleepiness, or unconsciousness due to the oxygen-deficient atmosphere.

b. Do not allow cleaning compound to contact skin for prolonged periods. The liquid chemically dries the skin, leaving it susceptible to infection.

c. Wear safety glasses or a face shield when using cleaning compound.

d. Wear breathing apparatus when using cleaning compound in confined or unventilated areas.

e. Do not subject cleaning compound to temperatures above 248° F.

1-12. ISOPROPYL ALCOHOL. Observe the following safety precautions when using isopropyl alcohol (Federal Specification TT-I-735):

a. Avoid inhalation of vapors of isopropyl alcohol, since inhalation may cause slight intoxication.

b. Wear breathing apparatus when using isopropyl alcohol in confined or unventilated areas.

c. Because of its low vaporizing qualities, use a minimum amount of isopropyl alcohol consistent with performing the task.

d. Wear safety glasses or a face shield when using isopropyl alcohol.

e. Do not use isopropyl alcohol near heat, sparks, or open flame.

1-13. DRYCLEANING SOLVENT. Observe the following safety precautions when using drycleaning solvent (Federal Specification P-D-680):

a. Do not use drycleaning solvent near heat, sparks, or open flame.

b. Wear safety glasses or a face shield when using drycleaning solvent.

c. Make sure that drycleaning solvent is kept away from areas that come in contact with liquid oxygen.

1-14. ACIDS.

1-15. Acids in either concentrated or diluted liquid form will soak through cloths causing severe burns, dissolve metals, give off harmful vapors, generate explosions, and cause fires upon contact with combustible material. Observe the following safety precautions when using acids:

a. Wear rubber or plastic gloves, apron, boots, and chemical-type safety goggles.

b. Avoid inhalation of vapors from liquids and dust from acid powder mixes.

c. Open acid containers, and use acid in well-ventilated areas. Avoid splashing and spilling.

d. Do not pour water into acid; slowly add acid to water, and constantly stir mixture with an acid-resistant implement.

e. Cloths, sponges, and brushes used to apply acid solutions must be thoroughly rinsed in tap water. If allowed to dry out without rinsing, they constitute a fire hazard.

f. If acid contacts skin, drench affected area in clean water for a minimum of 5 minutes.

g. Do not store acid near heat, caustics, water, or combustible materials.

1-16. LIQUID NITROGEN.

1-17. Liquid nitrogen is characterized by its extremely low temperature and high vapor pressure. Observe the following safety precautions when using liquid nitrogen:

a. Use only approved containers and storage vessels.

b. Wear safety goggles or face shield and loose, well-ventilated gloves or mittens.

c. Avoid splashing on exposed skin to prevent painful injury (burns).

d. Use in a well-ventilated area to prevent oxygen depletion.

e. Avoid direct contact with liquid or surfaces chilled by liquid.

1-18. INCOMPATIBLE MATERIALS.

1-19. Some materials, such as preservative compounds, lubricating oil, cleaning solvents, and grease, used for maintenance purposes are incompatible with the oxidizer (liquid oxygen) used in the engine. When introduced into an oxidizer system, liquid oxygen mixes with the incompatible material and becomes impact-sensitive and explosive. The detection of all incompatible materials in test equipment is difficult. Equipment must be protected by the methods outlined in applicable maintenance procedures to avoid the extensive disassembly required for detection and removal of incompatible materials.

1-20. CONTAMINATION AND DAMAGE PREVENTION REQUIREMENTS.

1-21. Contamination and damage prevention requirements for ground support equipment are listed in paragraphs 1-22 through 1-25.

1-22. CONTAMINATION PREVENTION.

1-23. All maintenance and repair procedures must be performed in such a manner as to prevent contamination of equipment that may be connected or attached to an engine system. These requirements are satisfied when the following conditions are met:

a. Clothing worn by personnel must be free of loose particles and fibers and pockets emptied of foreign objects that could contribute to contamination, when working with internal areas of systems or in controlled areas.

b. Parts, tools, materials, and test equipment actually used in a maintenance task must be accounted for to make sure that none of these items has been left inside a system.

c. All test equipment and tools must be clean if exposed to sealing surfaces or surfaces that contact operating fluid (liquid or gas).

d. Clean nylon or polyethylene gloves must be worn when handling parts or components where hand contact is made with sealing surfaces or surfaces that contact operating fluid (liquid or gas).

e. Necessary measures are taken to prevent contamination from wind and rain when a system is to be opened outdoors.

f. Areas are checked above, around, and below the system being opened for operations that may cause or allow contamination of the system. Proper measures are taken to prevent contamination of other systems from the system being opened.

g. A suitable container is provided to catch residual fluids when a system is opened, to prevent fluid from contaminating adjacent areas.

h. Only pressure-sensitive tape RB0195-002 (Rocketdyne), or equivalent, must be used to secure Aclar film or bags to components of fluid systems. Tape must not be used on threads, mating faces, or direct fluid surfaces. Tape alone must not be used as a closure and/or cover on openings or on removed components or assemblies.

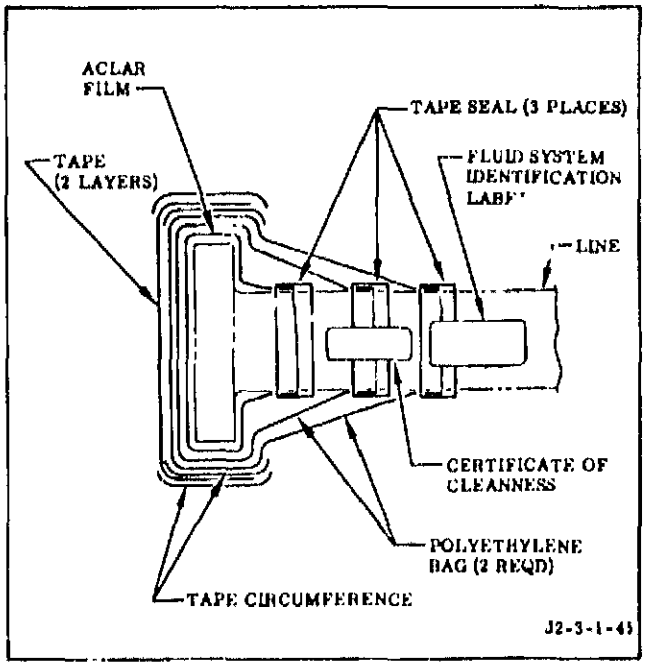


Figure 1-1. Protective Closure for Fluid Lines and Manifolds

i. Components and assemblies removed from a system must be immediately provided with suitable protective closures and/or coverings.

j. When the necessary fluid line closures are not available, the closure method shown in figure 1-1 and as follows must be used:

CAUTION

When securing Aclar film or bags to the line with tape, the tape must be wrapped completely around the line and a minimum of 25 percent of the tape width must contact the body of the line to prevent the entry of contaminants.

NOTE

The tape used in this procedure is pressure-sensitive tape RB0195-002 (Rocketdyne).

(1) Cover open ends of line with Aclar No. 33C film (0.002 inch minimum thickness) (Allied Chemical Corp). Wrap film over periphery of flange and secure to body of line with tape.

(2) Install a polyethylene bag (0.004 inch minimum thickness) (Cadillac Products) over Aclar film to completely cover and extend beyond film. Hold bag firmly against flange and body of line to exhaust any excess air from bag, and secure bag to body of line with tape.

(3) Attach a certificate of cleanness to taped area.

(4) Install a second polyethylene bag (0.004 inch minimum thickness) (Cadillac Products) over first bag. Hold bag firmly against flange and body of line to exhaust any excess air from bag, and secure bag to body of line with tape.

(5) Gather and tape bag over periphery of flange to prevent flange from cutting through bag.

(6) Apply 2 layers of tape over outer bag. Tape must cover surface of flange and extend over periphery of flange. Secure ends of tape by applying a layer of tape around periphery of flange.

1-24. DAMAGE PREVENTION.

1-25. All maintenance and repair procedures must be performed in such a manner as to minimize the possibility of damage to equipment. Damage will be greatly reduced by observing the following precautions:

a. Install covers and closures as necessary to protect system sealing surfaces and to protect equipment from the environment.

b. Do not step on or drive over hoses or electrical cables.

c. Inspect gaskets, O-rings, packings, and seals for usability before installation.

d. Make sure proper lubricant is used on fittings, gaskets, O-rings, packings, and seals when required by the applicable procedures and only in amount required.

e. Observe all precautions listed in repair and handling procedures.

f. Before use, inspect ground support and handling equipment for condition, and if equipment is proof-loaded, for evidence of current proof-loading.

g. Make sure electrical equipment is free of debris that might cause an electrical short.

h. Do not exceed handling equipment towing speed, turning radius, ramp angle, or load limits.

i. Use proper tools and equipment correctly. Avoid using adjustable wrenches.

j. Protect adjacent hardware from damage during removal and installation of large components.

k. Use tools that are free of sharp edges, burs, or other conditions that can damage tubes or fittings.

1-26. PRESSURIZING AND PURGING AGENT REQUIREMENTS.

1-27. Pressurizing and purging agents called out in this manual must conform to the requirements specified in the following paragraphs.

1-28. HELIUM. Helium, when specified in this manual, must conform to the requirements of Bureau of Mines, Grade A, have a water content less than that defined by a dewpoint of minus 80° F at standard atmospheric pressure, and be supplied from a system equipped with a 10-micron-nominal, 50-micron-absolute rated filter.

1-29. GASEOUS NITROGEN. Gaseous nitrogen, when specified in this manual, must conform to the requirements of MIL-P-27401. Air may be substituted for nitrogen if the air meets the cleanness and humidity requirements of MIL-P-27401.

1-30. LIQUID NITROGEN. Liquid nitrogen, when specified in this manual, must conform to the requirements of MIL-P-27401.

1-31. MATERIALS AND EQUIPMENT.

1-32. The materials listed in figure 1-2 are required for GSE maintenance, cleaning, paint stripping, repairing, and metal protection. The equipment listed in figure 1-3 is required for the examination of metals, maintenance, cleaning, paint stripping, and corrosion removal. After use, all materials and equipment must be thoroughly cleaned of all chemical and corrosion residue before reuse. All cloths and bristle brushes must be thoroughly washed and rinsed in tap water before reuse. Carbon-steel wool and wire brushes must be used on carbon steel or low-alloy steel materials. Stainless-steel wool and wire brushes must be used on corrosion-resistant steel (CRES) materials. Aluminum wool must be used on aluminum and magnesium. Brass wire brushes must be used to clean copper and copper alloy materials. It is recommended that a color code be established and that the handles of wire brushes be painted different colors to avoid possible misuse. Carborundum paper that is not discarded after use must be marked to indicate the type of metal on which it was used and must not be used on any other type of metal.

1-33. CORROSION.

1-34. Corrosion is the destructive conversion of metal to a metallic compound. Temperature, humidity, proximity of dissimilar elements, and electrical factors can retard or accelerate the pace of corrosion. All corrosion products in critical areas must be removed and a protective coating applied immediately to provide maximum protection. Failure to completely remove all corrosion products can leave a corrosion-prone area that may begin to corrode immediately despite the presence of a protective coating.

1-35. CORROSION-PRONE AREAS.

1-36. Certain materials and combination of materials are more prone to corrosive attack than others. During any inspection for corrosion, particular attention should be paid to parts and areas designated in the following paragraphs.

1-37. NUTS AND BOLTS. When using nuts and bolts or screws of different material than the parts they fasten, either the nut and bolt, or the parts they fasten, are prone to corrosion.

1-38. FLANGES AND CONNECTIONS. Where ducts, lines, and tubes are connected to dissimilar metals, a corrosive potential exists. Moisture from the duct, line, or tube, collecting on the lower flange or connection, becomes the electrolyte that starts the corrosive action.

1-39. WELD AREAS. Corrosion-resistant steel weld areas are corrosion-prone.

1-40. CREVICES AND JOINTS. Dirt and moisture tend to collect and remain in these areas and cause a corrosion-prone area.

1-41. DISSIMILAR METALS. When dissimilar metals are in electrical contact in the presence of an electrolyte, the less noble metal is prone to corrosion.

1-42. REMOVING PAINT FROM CORRODED AREAS.

1-43. All paint must be removed from any corroded area before corrosion removal and control procedures can be applied. Paint must be removed from the corroded area and from at least 2 inches of uncorroded metal around the area. Paint can be removed chemically or with a wire brush. Chemical paint removers must not be used in areas where the remover can become trapped. Paint and lacquer remover (Federal Specification TT-R-248) is not LOX-compatible; use dichloromethane (MIL-D-6998) near surfaces that require LOX-compatible materials.

a. Remove paint from areas where chemical removers can become trapped, with a wire brush and 280-grit Carborundum paper. Wipe area clean with a cloth dampened with tap water.

Identification	Name	Use
A-4000 (Dow Corning Corp)(a)	Adhesive	Bonding protective pads on Engine Vertical Installer G4035.
A-4000 (Dow Corning Corp)(a)	Catalyst	Bonding protective pads on Engine Vertical Installer G4035.
A-4014 (Dow Corning Corp)(a)	Primer	Repairing Engine Vertical Installer G4035 support ring hangers.
Aclar No. 33C (Allied Chemical Corp)	Film	Protecting open lines from contamination.
ADG (Stantron)	Dark gray enamel	Painting Flight Instrumentation Checkout Console G1035 cabinet and Data Recorder Console G3121 panels.
ALG (Stantron)	Light gray enamel	Painting Flight Instrumentation Checkout Console G1035 cabinet.
Alodine 1200 (Amchem Products)	Powder	Refinishing anodic-coated surfaces.
AMS3208	Rubber sheet (0.060 inch)	Replacing rubber seals on test plates (section VII).
AMS3651	Teflon sheet (0.002 inch)	Replacing protective surface on purge control and fast shutdown valve maintenance kit holding fixture (section XII, Volume II).
ANSTAC-2M (Chemical Development Corp)	Antistatic solution	Reducing buildup rate of static charge on flow tubes of Pneumatic Flow Tester G3104.
ARP No. 2 (Allied Research Products)	Detergent	Refinishing anodic-coated surfaces.
Bags and sheet (Cadillac Products)	Polyethylene	Protecting open lines, clean components, or component sealing surfaces from contamination. Additionally, polyethylene sheet protects electrical wiring and nonmetal parts during cleaning operations.
Bureau of Mines, Grade A	Helium	Leak- and function-testing and welding.
Cellosize HEC QP-15000 (Union Carbide)	Cleaner	Cleaning external surfaces.

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 1 of 12)

Identification	Name	Use
EC1300 or EC1300L (Minnesota Mining and Mfg)(a)	Adhesive	Cementing rubber pads on Engine Vertical Installer G4035 and Engine Handler G4064 and rubber sealing surfaces on test plates.
EC776 (Minnesota Mining and Mfg)(a)	Adhesive	Cementing Teflon sheet to test plates.
Epon 828 (Shell Chemical Co)(a)	Adhesive	Repairing Thrust Chamber Throat Plug G3120.
Ferrox C-507 (American Abrasive Metals Co)	Nonskid paint	Painting Engine Handler G4064 nonskid surfaces.
Freon TF (Du Pont)	Cleaner	Cleaning Thrust Chamber Throat Plug G3120.
FS1281 (Dow Corning Corp)	Grease	Lubricating O-rings, packings, and gaskets when servicing engine test plates, adapters, and tools (section VII). Lubricating threads on electrical connectors and coupling nuts on Automatic Inert Gas Arc Welding Set G3128.
Gloves (Plastic Smith)	Polyethylene gloves	Worn when using cleaning compound (MIL-C-81302), isopropyl alcohol (Federal Specification TT-I-735), or denatured alcohol (MIL-A-6091).
GR-362 (Hooker Chemical Corp)	Fluorolube grease	Lubricating components of engine components installers.
Insul cork 2755 (Armstrong Cork Co)	Cork	Replacing pad on pressure transducer torque wrench.
Iridite 14-2 (Allied Research Products)	Powder	Refinishing anodic-coated surfaces.
KEL-F 90 (Minnesota Mining and Mfg)	Lubricant	Installing Engine Vertical Installer G4035 electrical controller box cover.
MIL-A-18455	Argon gas	In-place tube welding.
MIL-A-5092, Type II	General purpose adhesive	Cementing rubber seal to test plates.
MIL-A-6091	Denatured alcohol	Cleaning interior surfaces of electrical connectors.

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 2 of 12)

Identification	Name	Use
MIL-B-121, Grade A	Greaseproof barrier material	Protecting equipment during storage.
MIL-C-16173	Corrosion-preventive compound	Protecting unpainted carbon steel working surfaces from corrosion. Protecting against corrosion when dissimilar metals are joined.
MIL-C-25769	Alkaline cleaning compound	Cleaning painted aluminum alloy surfaces before corrosion removal.
MIL-C-5410, Type II	Cleaning compound	Deoxidizing parts for anodic surface refinishing.
MIL-C-5541	Chemical film	Protecting unpainted aluminum alloy surfaces from corrosion.
MIL-C-81302[b]	Cleaning compound	Cleaning burst diaphragms, CRES, and cadmium-, chrome-, nickel-, and silver-plated parts during corrosion removal. Cleaning external surfaces. Maintaining spark igniter cable pressurization tool kit 9025425 electrical package pressure monitor adapter assembly. Cementing rubber pads and Teflon gaskets on components of engine components installers. Lubricating ball-lock pins.
MIL-D-6998	Dichloromethane	Removing paint from corroded surfaces.
MIL-E-15090, Type III, Class 2	Light-gray enamel	Painting spark monitor turbine overspeed cutoff test set 9024499 and vibration safety cutoff test set 9024498 case interiors.
MIL-E-16053, Type 4043	Welding rod	Repairing electrical interface support 9024460.
MIL-E-16053, Type 5183	Welding rod	Repairing valves buildup fixture kit 9022337 (section XII, Volume II).
MIL-E-5556, color 31136 (Federal Standard 595)	Camouflage enamel	Painting inlet duct support frame installing tool kit 9025150 turnbuckle barrel ends.

(b) Cleaning agent MSFC-237A can be subsituted for all cleaning tasks.

Figure 1-2. Materials Specified in This Manual (Sheet 3 of 12)

Identification	Name	Use
MIL-E-5556, Color 37038 (Federal Standard 595)	Camouflage enamel	Stenciling proof-test weights.
MIL-G-23827	Gear grease	Lubricating components of engine components installers, Engine Handler G4064, and Engine Vertical Installer G4035. Lubricating ball-lock pins.
MIL-G-7711	General purpose grease	Lubricating Single Head Special Tool Kit G3127 flexible shaft.
MIL-L-19538, color 37038 (Federal Standard 595)	Camouflage lacquer	Painting Engine Handler G4064.
MIL-L-19538, color 37875 (Federal Standard 595)	Camouflage lacquer	Painting markings on Engine Handler G4064 deck lids.
MSFC-SPEC-384	Leak-test compound	Leak testing.
MIL-L-6086	Lubricating oil	Lubricating Engine Vertical Installer G4035.
MIL-L-11414	Lacquer primer	Priming coat for carbon steel surfaces. Protecting against corrosion when dissimilar metals are joined.
MIL-P-27401	Gaseous nitrogen	Cleaning, drying, and pressurizing.
MIL-P-[illegible]01	Liquid nitrogen	Servicing components adapter set 9016796 leak detector set.
MIL-P-8585[(a)]	Zinc chromate primer	Priming coat for aluminum alloys and carbon steel. Protecting against corrosion when dissimilar metals are joined.
MIL-R-5031, Class A	CRES 347 filler rod or wire	Repairing valves buildup fixture kit 9022337 (section XII, Volume II).

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 4 of 12)

Identification	Name	Use
MIL-T-27602	Trichloroethylene	Cleaning CRES, and cadmium-, chrome-, nickel-, and silver-plated parts during corrosion removal. Washing Flight Instrumentation Checkout Console G1035 blower filter. Repairing Outboard Engine Restrainer G4066. Installing Engine Vertical Installer G4035 electrical controller box cover. Cleaning spark igniter cable pressurization tool kit 9025425 manifold filter and outer housing. Maintaining spark igniter cable pressurization tool kit 9025425 electrical package pressure monitor adapter assembly. Cementing rubber pads and Teflon gaskets on components of engine components installers. Lubricating ball-lock pins.
MIL-T-81533	Trichloroethane	Cleaning. Cementing rubber pads and Teflon gaskets on components of engine components installers. Lubricating ball-lock pins.
MIL-V-173	Moisture- and fungus-resistant varnish	Protecting Engine Vertical Installer G4035 electrical components.
MIL-V-6894	Varnish	Lubricating, when replacing threaded insert in Thrust Chamber Throat Plug Kit G3120.
Molykote G (Dow Corning Corp)	Paste	Lubricating Data Recorder Console G3121 event recorder, vertical installer and engine sling proof-test weights 9025145, and components of engine components installer.
Molykote Z (Dow Corning Corp)	Powder	Lubricating Engine Handler G4064.
MS20995N20 and MS20995N32	Lockwire	Safetywiring.
N-1 (Marsh Stencil Machine Co)	Metal marking ink	Painting markings on Engine Handler G4064 dust cover.
No number	Acid-resistant-bristle brush	Cleaning external surfaces (alternates: cotton swabs or clean cloth).
No number	Aluminum wool	Removing corrosion from aluminum alloy surfaces.

Figure 1-2. Materials Specified in This Manual (Sheet 5 of 12)

Identification	Name	Use
No number	Carbon steel wool	Removing corrosion from carbon steel surfaces.
No number	Cotton swabs	Cleaning external surfaces (alternates: acid-resistant-bristle brush or clean cloth).
No number	Denatured alcohol	Leak-testing relief valve RD284-5006-0500 (section VII, Volume I).
No number	Distilled or deionized water	Cleaning and rinsing parts, and combining with cleaning compound (MIL-C-5410) when deodorizing part for anodic refinishing.
No number	Nylon-bristle brush	Cleaning parts.
No number	Paper towels	Cleaning external surfaces.
No number	Polyethylene foam and polyurethane foam	Cushioning for packaging parts.
No number	Seals, labels, and decals	Identifying clean parts.
No number	Soft, clean cloth	Cleaning test consoles and panels. Applying Iridite or Alodine solution. (Alternate: soft-bristle brush)
No number	Sponge	Absorbing excess water during cleaning operations.
No number	Stainless-steel wool	Removing corrosion from CRES surfaces.
No number	Vinyl bags	Packaging cleaned parts.
No number	1-grit (or finer) sandpaper	Repairing Thrust Chamber Throat Plug G3120.
No number	250-grit (or finer) abrasive cloth	Repairing Microbol protective coatings.
No number	280-grit (or finer) Carborundum paper	Removing corrosion.
No number	400-grit (or finer) Carborundum paper	Removing corrosion from metal.
No number	400-grit (or finer) sandpaper	Removing corrosion from electrical components and unpainted metal surfaces of Engine Vertical Installer G4035.

Figure 1-2. Materials Specified in This Manual (Sheet 6 of 12)

Identification	Name	Use
No. 50 (Houghton Products)	Rust inhibitor	Protecting Automatic Inert Gas Arc Welding Set G3128 water tank from corrosion.
No. 7815 (Victor Gloves, Inc)	Nylon cloth	Cleaning parts, wiping, performing soil test, and inspecting Molykote Z powder application.
No. 7862 (Victor Gloves, Inc)	Nylon gloves	Handling clean parts.
O-A-51 (Federal Specification)	Acetone	Repairing Outboard Engine Restrainer G4066.
Oakite No. 61B (Oakite Products, Inc)	Cleaner	Cleaning parts that do not connect to pneumatic or propellant systems and do not have adhesive-bonded surfaces.
P-D-680 (Federal Specification)	Drycleaning solvent	Cleaning bearings and ball lock-pins before relubricating and carbon steel surfaces during corrosion removal. Cleaning test consoles and electrical components. Cleaning surfaces for Microsol repair.
Paint (Startron)	Gray enamel	Painting Pneumatic Console G3106 console.
Permacel P422 (Johnson and Johnson, Inc)	Tape (0.0035 inch)	Replacing plastic film sealing surfaces on test plates (section VII).
PPP-T-60 (Federal Specification)	Waterproof tape	Securing polyethylene sheet or bags to components or sealing surface.
PR-1531 (Products Research and Chemical, Semco)(a)	Primer	Repairing Outboard Engine Restrainer G4066.
PR-1532 (Products Research and Chemical, Semco)(a)	Potting compound	Repairing Outboard Engine Restrainer G4066.
P29R (Permacel)	Plastic electrical tape	Insulating Automatic Inert Gas Arc Welding Set G3128 welding cables.
P32 (Johnson and Johnson, Inc)	Polyvinyl tape (white and black)	Replacing Microsol protective coatings.

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 7 of 12)

Identification	Name	Use
RB0130-008 (Rocketdyne)	Teflon sheet	Replacing Teflon sheet sealing surfaces on test plates (section VII) and maintenance kits (section XII, Volume II).
RB0140-002 (Rocketdyne)	Thread sealant tape	Preventing corrosion where clamp metal and metal to which clamp is attached are of different material.
RB0140-005 (Rocketdyne)	Sealing and antiseize compound	Lubricating Thrust Chamber Throat Plug Kit G3120 burst diaphragm threads and packing. Lubricating threads of burst diaphragms when servicing engine test plates, adapters, and tools (section VII).
RB0140-011 (Rocketdyne)	Chlorotrifluoroethylene grease	Lubricating Components Adapter Set 9016796 leak detector set.
RB0140-012 (Rocketdyne)	Lubricant grease	Lubricating bypass valve removal tool kit 9020269 (section VII) nd spark igniter cable pressurization tool kit 9025425 crimping tool.
RB0195-002 (Rocketdyne)	Pressure-sensitive tape	Securing polyethylene sheet or bags to components or sealing surfaces. Securing Aclar film and polyethylene bags to open lines.
RB0210-002 (Rocketdyne)	Alkaline cleaner	Cleaning Automatic Inert Gas Arc Welding Set G3128 cover. Removing static charge from Automatic Gas Arc Welding Set G3128 electrical gage lenses. Cleaning Engine Handler G4064 engine cover and engine dust cover.
RB0210-003 (Rocketdyne)	Trichloroethylene	Cleaning Pneumatic Flow Tester G3104 meters.
RB0210-005 (Rocketdyne)	Alkaline cleaner	Cleaning Pneumatic Flow Tester G3104 hoses and adapters. Cleaning Automatic Inert Gas Arc Welding Set G3128 cover. Removing static charge from Automatic Inert Gas Arc Welding Set G3128 electrical gage lenses. Cleaning Engine Handler G4064 engine cover and engine dust cover. Cleaning components of engine components installers.

Figure 1-2. Materials Specified in This Manual (Sheet 8 of 12)

Identification	Name	Use
RB0210-016 (Rocketdyne)	Corrosion preventative	Protecting unpainted carbon steel stationary surfaces from corrosion.
RTV-103 (General Electric)(a)	Black sealant	Installing Engine Vertical Installer G4035 electrical controller box cover.
SAE-10	Machine oil	Lubricating Data Recorder Console G3121 event recorder.
SC510, ABF_1K_2 (MIL-R-3065)	Rubber (0.062 inch)	Replacing rubber seals on test plates (section VII).
SC710, ABF_1K_2 (MIL-R-3065)	Rubber (0.062 inch)	Replacing rubber seals on test plates (section VII).
SKB-F (Magnaflux Corp)	Spot-check developer	Dye-penetrant inspecting.
SKB-S (Magnaflux Corp)	Spot-check developer	Dye-penetrant inspecting.
SKD-NF (Magnaflux Corp)	Spot-check developer	Dye-penetrant inspecting.
SKL-4 (Magnaflux Corp)	Dye-penetrant	Dye-penetrant inspecting.
SN60 or SN63 (Federal Specification QQ-S-571)	Lead-tin solder	Repairing Single Head Special Tool Kit G3127.
ST0125RB0003 (Rocketdyne)	Blue-tinted lacquer	Protecting bonded surfaces from corrosion.
TEC 901 (TEC Chemical Co)	Cleaner	Cleaning unpainted aluminum alloy surfaces during corrosion removal.
Testors vinyl cement (The Testors Corp)	Cement	Repairing Engine Handler G4064 covers.
Turco Dy-Check Kit No. 25 (Turco Products)	Dye penetrant kit	Dye-penetrant inspecting Outboard Engine Restrainer G4066.
TT-E-489 (Federal Specification), color 11136 (Federal Standard 595)	Enamel	Painting Engine Handler G4064, propellant feed system handlers, fluid lines interface support 9020628, interface arm support 9026988, and engine components installers.

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 9 of 12)

Identification	Name	Use
TT-E-489 (Federal Specification), color 13538 (Federal Standard 595)	Enamel	Painting Automatic Inert Gas Arc Welding Set G3128, proof-test weights, Engine Handler G4064, Engine Vertical Installer G4035, sequence controller and oxidizer heat exchanger handlers, propellant inlet duct handlers, propellant feed system handlers, Start Tank Installer 9016783, and engine components installers.
TT-E-489 (Federal Specification), color 17038 (Federal Standard 595)	Enamel	Painting Engine Handler G4064 and propellant feed system handlers
TT-E-489 (Federal Specification), color 27038 (Federal Standard 595)	Enamel	Stenciling Automatic Inert Gas Arc Welding Set G3128.
TT-E-489 (Federal Specification), color 31136 (Federal Standard 595)	Enamel	Painting Engine Vertical Installer G4035.
TT-E-527 (Federal Specification), color 34300 (Federal Standard 595)	Lustreless enamel	Painting Pneumatic Flow Tester G3104 case exterior.
TT-E-529 (Federal Specification), color 26251 (Federal Standard 595)	Enamel	Painting Components Adapter Set 9016796 storage cabinet.
TT-E-529 (Federal Specification), color 26440 (Federal Standard 595)	Enamel	Painting Electrical Checkout Console G1037, Flight Instrumentation Checkout Console G1035 calibration control and signal conditioner panels, Data Recorder Console G3121 panels, Pneumatic Console G3106 panels, Gas Generator High-Low Temperature Cutoff Panel G1047, spark monitor turbine overspeed cutoff test set 9024499 and, vibration safety cutoff test set 9024498.
TT-E-529 (Federal Specification), color 26622 (Federal Standard 595)	Enamel	Painting Pneumatic Flow Tester G3104 instrument panel.
TT-I-735 (Federal Specification)	Isopropyl alcohol	Cleaning interior and exterior surfaces of electrical connectors.
TT-L-20 (Federal Specification), color 37038 (Federal Standard 595)	Camouflage lacquer	Painting Engine Components Installers.

Figure 1-2. Materials Specified in This Manual (Sheet 10 of 12)

Identification	Name	Use
TT-L-32 (Federal Specification), color 11136 (Federal Standard 595)	Cellulose lacquer	Painting Engine Components Installers.
TT-L-32 (Federal Specification), color 17038 (Federal Standard 595)	Cellulose lacquer	Painting obliterated identification markings on Film-Cooled Diffuser G4070, sequence controller and oxidizer heat exchanger handlers, propellant inlet duct handlers, propellant feed system handlers, start tank installer 9016783, and engine components installers.
TT-L-32 (Federal Specification), color 23538 (Federal Standard 595)	Cellulose lacquer	Stenciling Engine Vertical Installer G4035.
TT-L-32 (Federal Specification), color 27038 (Federal Standard 595)	Cellulose lacquer	Stenciling Engine Vertical Installer G4035.
TT-L-32 (Federal Specification), color 31136 (Federal Standard 595)	Cellulose lacquer	Painting Film-Cooled Diffuser G4070 diffuser.
TT-L-32 (Federal Specification), color 37038 (Federal Standard 595)	Cellulose lacquer	Stenciling Film-Cooled Diffuser G4070.
TT-L-32 (Federal Specification), color 37875 (Federal Standard 595)	Cellulose lacquer	Stenciling electrical interface support 9024460 and fluid lines interface arm support 9026988.
TT-M-261 (Federal Specification)	Methyl-ethyl-ketone	Cleaning electrical cables. Repairing Engine Vertical Installer G4035.
TT-N-95 (Federal Specification)	Naphtha	Cleaning electrical contacts on Flight Instrumentation Checkout Console G1035.
TT-R-248 (Federal Specification)	Paint and lacquer remover	Removing paint from corroded surfaces.
TT-T-548 (Federal Specification)	Toluene	Cleaning leak detector cold trap bucket (section V, Volume II). Bonding protective pads on Engine Vertical Installer G4035. Cementing rubber pads on components of engine components installers.
Turco 4215 (Turco Products)	Additive	Cleaning streamers.

Figure 1-2. Materials Specified in This Manual (Sheet 11 of 12)

Identification	Name	Use
Turco 4518 (Turco Products)	Cleaner	Cleaning external surfaces.
UU-T-106 (Federal Specification)	Masking tape	Repairing Thrust Chamber Throat Plug G3120.
Versamid 125 (General Mills)(a)	Adhesive	Repairing Thrust Chamber Throat Plug G3120.
VK-193-0030 (Navan, Inc)(a)	Adhesive	Repairing Engine Handler G4064 covers (alternate: Testors vinyl cement).
VV-L-800 (Federal Specification)	Lubricating oil	Protecting unpainted carbon steel working surfaces from corrosion. Lubricating Engine Handler G4064 and Engine Vertical Installer G4035.
WD-40 (Rocket Chemical Co)	Preservative	Protecting cadmium-, chrome-, nickel-, or silver-plated surfaces from corrosion. Protecting Engine Handler G4064 parts from corrosion.
170-H-64 (W. P. Fuller Paint Co)	Gray paint	Painting spark monitor turbine overspeed cutoff test set 9024499 and vibration safety cutoff test set 9024498 case exteriors.
17'. 7 (Osborne Mfg Co)	Carbon-steel-wire brush	Removing corrosion from carbon steel surfaces.
1777-SV-48 (Osborne Mfg Co)	Stainless-steel-wire brush	Removing corrosion from CRES surfaces.
19263-4 (Rotron, Inc)	Lubricating oil	Lubricating amplifer mounting panel 9024500 slower.
225 (Ram Chemicals, Inc)	Mold release	Coating Automatic Inert Gas Arc Welding Set G3128 cover zipper.
263-D (Osborne Mfg Co)	Soft-bristle brush	Cleaning surfaces and applying Iridite or Alodine solution.
549 (Minnesota Mining and Mfg)	Plastic film	Replacing plastic film sealing surfaces on test plates (section VII).
584 (Coast Pro-Seal)(a)	Adhesive	Cementing rubber pads on engine component installers.
910 (Eastman)(a)	Cement	Cementing cork pad on pressure transducer torque wrench 9025822.

(a) Compound has limited shelf life. Refer to age-controlled compounds in R-3825-3 for usability test.

Figure 1-2. Materials Specified in This Manual (Sheet 12 of 12)

Specification or Part No.	Name	Use
MISCELLANEOUS		
4 AWG (General Cable Corp)	Cable	Ground cable for Engine Vertical Installer G4035.
462 (J. H. Williams and Co)	Spanner wrench, 3-1/2 inch	Adjusting height of components installer track.
31224 (Thomas and Betts Co)	Clamp	Securing ground cable for Engine Vertical Installer G4035.
REPAIR		
R1108-W (Rosan, Inc)	Wrench	Installing Rosan inserts.
R3608-D (Rosan, Inc)	Drive tool	Installing Rosan lockrings.
T428 (Newton Division, Tridair Industries)	Tool	Installing Keenserts inserts.
T428L (Newton Division, Tridair Industries)	Tool	Installing Keenserts inserts.
TH820L (Newton Division, Tridair Industries)	Tool	Installing Keenserts inserts.
1193-4 (Heli-Coil Corp)	Plug-style STI tap	Installing Heli-Coil inserts.
1193-5 (Heli-Coil Corp)	Plug-style STI tap	Installing Heli-Coil inserts.
1193-6 (Heli-Coil Corp)	Plug-style STI tap	Installing Heli-Coil inserts.
1196-3 (Heli-Coil Corp)	Plain-insert tang break-off tool	Installing Heli-Coil inserts.
1196-4 (Heli-Coil Corp)	Plain-insert tang break-off tool	Installing Heli-Coil inserts.
1196-5 (Heli-Coil Corp)	Plain-insert tang break-off tool	Installing Heli-Coil inserts.
1196-6 (Heli-Coil Corp)	Plain-insert tang break-off tool	Installing Heli-Coil inserts.
1196-8 (Heli-Coil Corp)	Plain-insert tang break-off tool	Installing Heli-Coil inserts.
1227-6 (Heli-Coil Corp)	Heli-coil insert extracting tool	Installing Heli-Coil inserts.
1694-3 (Heli-Coil Corp)	Threaded plug reference gage	Installing Heli-Coil inserts.

Figure 1-3. Equipment for Maintenance and Repair (Sheet 1 of 7)

Specification or Part No.	Name	Use
REPAIR (cont)		
1694-4 (Heli-Coil Corp)	Threaded plug reference gage	Installing Heli-Coil inserts.
1694-5 (Heli-Coil Corp)	Threaded plug reference gage	Installing Heli-Coil inserts.
1694-6 (Heli-Coil Corp)	Threaded plug reference gage	Installing Heli-Coil inserts.
1694-8 (Heli-Coil Corp)	Threaded plug reference gage	Installing Heli-Coil inserts.
23193-3 (Heli-Coil Corp)	Plug-style STI tap	Installing Heli-Coil inserts.
27193-3 (Heli-Coil Corp)	Bottoming-style STI tap	Installing Heli-Coil inserts.
3581-3 (Heli-Coil Corp)	Mid-grip insert tang break-off tool	Installing Heli-Coil inserts.
3581-4 (Heli-Coil Corp)	Mid-grip insert tang break-off tool	Installing Heli-Coil inserts.
3581-5 (Heli-Coil Corp)	Mid-grip insert tang break-off tool	Installing Heli-Coil inserts.
3581-6 (Heli-Coil Corp)	Mid-grip insert tang break-off tool	Installing Heli-Coil inserts.
3581-8 (Heli-Coil Corp)	Mid-grip insert tang break-off tool	Installing Heli-Coil inserts.
3694-3 (Heli-Coil Corp)	Threaded plug working gage	Installing Heli-Coil inserts.
3694-4 (Heli-Coil Corp)	Threaded plug working gage	Installing Heli-Coil inserts.
3694-5 (Heli-Coil Corp)	Threaded plug working gage	Installing Heli-Coil inserts.
3694-6 (Heli-Coil Corp)	Threaded plug working gage	Installing Heli-Coil inserts.
3694-8 (Heli-Coil Corp)	Threaded plug working gage	Installing Heli-Coil inserts.
42193-8 (Heli-Coil Corp)	Plug-style STI tap	Installing Heli-Coil inserts.
44193-8 (Heli-Coil Corp)	Bottoming-style STI tap	Installing Heli-Coil inserts.
5193-4 (Heli-Coil Corp)	Bottoming-style STI tap	Installing Heli-Coil inserts.
5193-5 (Heli-Coil Corp)	Bottoming-style STI tap	Installing Heli-Coil inserts.
5193-6 (Heli-Coil Corp)	Bottoming-style STI tap	Installing Heli-Coil inserts.

Figure 1-3. Equipment for Maintenance and Repair (Sheet 2 of 7)

Specification or Part No.	Name	Use
REPAIR (cont)		
7552-3 (Heli-Coil Corp)	Plain or mid-grip insert inserting tool	Installing Heli-Coil inserts.
7552-4 (Heli-Coil Corp)	Plain or mid-grip insert inserting tool	Installing Heli-Coil inserts.
7552-5 (Heli-Coil Corp)	Plain or mid-grip insert inserting tool	Installing Heli-Coil inserts.
7552-6 (Heli-Coil Corp)	Plain or mid-grip insert inserting tool	Installing Heli-Coil inserts.
7552-8 (Heli-Coil Corp)	Plain or mid-grip insert inserting tool	Installing Heli-Coil inserts.
Local purchase	Square screw extractor	Removing Rosan inserts.
Local purchase	Arbor press	Broaching Keenserts inserts Kee slots.
Local purchase	E-Z Out extraction tool	Extracting Keenserts inserts.
SERVICE		
	Grease gun	Applying lubricants.
	Air-circulating oven	Drying cleaned parts.
	Vacuum cleaner	Cleaning electrical components.
TEST		
Model AW (Ester Angus)	Pen recorder	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
EWR828272-1, -2	Adapters	Proof-testing engine components installers.
GLD-1 or GLD-5 (Bussman)	Blown fuse	Function-testing Electrical Checkout Console G1037.
MAL series (General Electric)	Capacitor, 0.001 uf Capacitors, 0.002 uf (2 required)	Testing high-voltage leakage tester (section V, Volume II).
MST500-4-6 (Standard Electric Time Co)	Millisecond timer	Adjusting time delay relays (section IV).
NA5-27292T1 (Rocketdyne)	Relay	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045.

Figure 1-3. Equipment for Maintenance and Repair (Sheet 3 of 7)

Specification or Part No.	Name	Use
TEST (cont)		
XEOR923020	Engine lowering fixture	Proof-testing engine components installers.
Model 53/54C (Tektronix)	Oscilloscope plug-in unit	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045, spark monitor turbine overspeed cutoff test set 9024499, and vibration safety cutoff test set 9024498.
Type 53/54D (Tektronix)	Preamp module	Function-testing Electrical Checkout Console G1037.
Model 200CD (Hewlett-Packard)	Oscillator	Function-testing Data Recorder Console G3121 and Spark Monitor/Overspeed Cutoff Panel G1045.
Model 260 (Simpson)	Multimeter	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045, spark monitor turbine overspeed cutoff test set 9024499, and vibration safety cutoff test set 9024498.
Model 400H (Hewlett-Packard)	VTVM	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045.
Model 410B (Hewlett-Packard)	VTVM	Function-testing dc hypot (section V, Volume II).
Model 459A (Hewlett-Packard)	Resistive voltage multiplier	Function-testing dc hypot (section V, Volume II).
Model 523CR (Hewlett-Packard)	Frequency counter	Function-testing Flight Instrumentation Checkout Console G1035 and Data Recorder Console G3121.
Model 535 (Tektronix)	Oscilloscope	Function-testing Electrical Checkout Console G1037, Spark Monitor/Overspeed Cutoff Panel G1045, spark monitor turbine overspeed cutoff test set 9024499, and vibration safety cutoff test set 9024498.
Model 630-A (Triplett)	Multimeter	Function-testing Electrical Checkout Console G1047, Flight Instrumentation Checkout Console G1035, and Data Recorder Console G3121, and testing dc hypot (section V, Volume II).

Figure 1-3. Equipment for Maintenance and Repair (Sheet 4 of 7)

Specification or Part No.	Name	Use
TEST (cont)		
Model 801 (John Fluke Co)	Differential DC voltmeter	Function-testing Electrical Checkout Console G1037 and spark monitor turbine overspeed cutoff test set 9024499.
Model 803 (John Fluke Co)	DC voltmeter	Function-testing Data Recorder Console G3121.
Model 803B (John Fluke Co)	VTVM	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
1803-B (General Electric)	VTVM	Function-testing spark monitor turbine overspeed cutoff test set 9024499.
1806 (General Radio)	VTVM	Function-testing Electrical Checkout Console G1037.
2112-D-H1 (Elastic Stop Nut Corp)	Time-delay relay	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045.
5273 (Harvey-Hubell)	Plug-in adapter	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045.
Model 5305 (Leeds and Northrup Co)	Wheatstone bridge	Testing patch-cords (section V, Volume II).
7150 (Beckman)	Frequency counter recorder	Function-testing Electrical Checkout Console G1037, Spark Monitor/Overspeed Cutoff Panel G1045, and spark monitor turbine overspeed cutoff test set 9024499.
Model 7553-K3 (Leeds and Northrup Co)	Potentiometer	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
	Ice water containers (Dewars)	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
	Counterbalance, 2,500-pound	Proof-testing engine components installers.
	Gage, 0-100 psi, ±0.5% accuracy, one-psi increments maximum	Function-testing Pneumatic Console G3106.
	Gage, 0-160 psi, ±0.5% accuracy, one-psi increments maximum	

Figure 1-3. Equipment for Maintenance and Repair (Sheet 5 of 7)

Specification or Part No.	Name	Use
TEST (cont)		
	Gage, 0-800 psi, ±0.5% accuracy, 10-psi increments maximum	
	Gage, 0-1,500 psi, ±0.5% accuracy, 10-psi increments maximum	
	Gage, 0-5,000 psi, ±0.5% accuracy, 50-psi increments maximum	
	Monocular magnifier, 4-power	Inspecting for corrosion.
	Water manometer (30 inches minimum)	Function-testing Pneumatic Flow Tester G3104.
	Piezometer, 3/8-inch	Function-testing Pneumatic Flow Tester G3104.
	Regulated power supply, 0-50 vdc	Adjusting time delay relays (section IV).
	DC variable power supply, 0-60 millivolts	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
	Power supply, 0-30 vdc, 100 volt-amperes	
	Power supply, 18-32 vdc	Function-testing Spark Monitor/ Overspeed Cutoff Panel G1045.
	Power supply, 22-32 vdc	Function-testing spark monitor turbine overspeed cutoff test set 9024499.
	Power supply, 26-30 vdc	Function-testing vibration safety cutoff test set 9024498.
	Potentiometers, 1K and 20K	Calibrating Gas Generator High-Low Temperature Cutoff Panel G1047.
	Resistors, 100K, one-watt (11 required)	Function-testing high-voltage leakage tester (section V, Volume II).
	Resistor, 700-ohm, 2-watt	Function-testing vibration safety cutoff test set 9024498.

Figure 1-3. Equipment for Maintenance and Repair (Sheet 6 of 7)

Specification or Part No.	Name	Use
TEST (cont)		
	Flow calibration, standard ±1.0% accuracy at indicated reading	Function-testing Pneumatic Flow Tester G3104.
	Supports, 2 by 4 by 24 inches 2 by 4 by 45 inches (3 required) 6 by 30 by 30 inches 14 by 24 by 24 inches 23 by 36 by 36 inches 23-1/4 by 30 by 60 inches (4 required)	Proof-testing engine components installers.
	Switch, single-pole, single-throw	Calibrating Spark Monitor/Overspeed Cutoff Panel G1045.
	Thermocouple lead, chromel alumel	Function-testing Gas Generator High-Low Temperature Cutoff Panel G1047.
	Test thermocouple	
	Mercury thermometer, 40° to 100° F	Function-testing Pneumatic Flow Tester G3104.
	Shutoff valve, 4,500-psi	Function-testing Pneumatic Console G3106.
	Proof-test weights: 60 ±3 pounds 66 ±3 pounds 200 ±10 pounds 300 ±15 pounds 400 ±8 pounds 400 ±20 pounds 500 ±10 pounds 500 ±15 pounds 600 ±30 pounds 700 ±25 pounds 880 ±25 pounds 1,100 ±20 pounds 1,120 ±20 pounds 1,120 ±25 pounds 1,200 ±24 pounds 1,200 ±25 pounds 1,200 ±50 pounds 1,600 ±40 pounds 2,000 ±50 pounds 6,520 ±100 pounds 12,400 ±250 pounds in 30-50 pound weights	Proof-testing engine components installers.

Figure 1-3. Equipment for Maintenance and Repair (Sheet 7 of 7)

WARNING

The following procedure specifies paint and lacquer remover (Federal Specification TT-R-248), which is corrosive and forms and explosive gel when mixed with liquid oxygen, creating a hazard to both personnel and equipment.

b. Where chemical removers can be used, remove paint as follows: (Use dichloromethane (MIL-D-6998) on areas that have direct or indirect contact with liquid oxygen or where structural complexities make it impossible to use a thickened paint remover. Use paint and lacquer remover (Federal Specification TT-R-248) on areas that do not have direct or indirect contact with liquid oxygen and where a thickened paint remover can be used.)

(1) Using a stiff-bristle brush, apply dichloromethane (MIL-D-6998) or paint and lacquer remover (Federal Specification TT-R-248), as applicable, to paint on corroded area.

(2) Allow chemical to remain on surface until paint softens and lifts.

CAUTION

Paint remover remaining on the surface can cause corrosion.

(3) Wash away loosened paint and remover or wipe from surface with a clean cloth frequently rinsed in tap water.

(4) Repeat substeps 1 through 3 until all paint is removed from surface.

(5) Wipe surface dry with clean, dry cloth.

1-44. CLEANING CORRODED SURFACES.

1-45. Before corrosion removal and control procedures (paragraphs 1-46 through 1-53) are performed, the corroded surfaces must be cleaned as follows:

a. Remove loosely adhering grease, paint, oil, dirt, and other foreign substances by wiping.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

- The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

b. See figure 1-4 and clean corroded surfaces using cleaning agent and procedures noted.

c. If it is possible to isolate corroded area, seal off all nearby surfaces from cleaning agent, using moisture-proof cloth, tape, and drip pans.

d. Apply cleaning agent to surface with clean cloth or soft-bristle brush. On large, level surfaces pour cleaning agent directly on surface.

e. Allow cleaning agent to remain on surface for several minutes; then scrub with cloth or bristle brush. Do not allow cleaner to dry on surface.

f. Wipe surface thoroughly with a clean, dry cloth.

g. Rinse surface thoroughly with distilled or deionized water before alkaline cleaning compound dries. Allow surface to dry completely.

Material	Cleaning Agent	Paragraph 1-45, Steps
Carbon steel	Drycleaning solvent (Federal Specification P-D-680 Type I)(a)	c through f
CRES and nickel alloys; and cadmium-plated, chrome-plated, nickel-plated, and silver-plated parts	Trichloro-ethylene (MIL-T-27602)	c through f
Aluminum alloy (painted)	Alkaline cleaning compound (MIL-C-25769)	c through e and g
Aluminum alloy (unpainted)	TEC 901 (TEC Chemical Co)	h through j

(a) If use of flammable solvent is prohibited, use cleaning compound (MIL-C-81302).

Figure 1-4. Materials and Procedures for Cleaning Corroded Surfaces

CAUTION

Avoid using excessive amounts of TEC 901 to prevent uncontrolled running or dripping. TEC 901 can remove paint or protective finishes from adjacent surfaces, causing corrosion.

h. Apply TEC 901 (TEC Chemical Co) with a clean, soft cloth. Apply in long strokes to remove all foreign deposits and accumulations of grease and dirt.

i. Repeat step h as necessary, using a fresh application of chemical and a clean cloth until surface is clean.

j. For final wipe, squeeze cloth as dry as possible.

1-46. REMOVING CORROSION FROM CARBON STEEL.

1-47. Remove corrosion from carbon steel as follows:

a. Clean area in accordance with instructions in paragraph 1-44.

b. If surface is painted, remove paint in accordance with instructions in paragraph 1-42.

c. On small or complex components, remove all corrosion products using carbon-steel wool or 400-grit Carborundum paper. On large, heavy equipment, a carbon-steel-wire brush may be used to remove surface corrosion deposits.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

d. Rinse area with drycleaning solvent (Federal Specification P-D-680, Type I), and wipe dry.

e. Inspect area for corrosion with a 4-power monocular magnifier. If all corrosion has not been removed, repeat steps c and d.

WARNING

The following procedure specifies corrosion-preventive compound (MIL-C-16173), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the compound can cause serious injury.

f. Apply lubricating oil (Federal Specification VV-L-800) to unpainted working surfaces, and corrosion-preventive compound (MIL-C-16173, Grade 1) or corrosion preventative RB0210-016 (Rocketdyne) to unpainted stationary surfaces.

NOTE

Corrosion preventative RB0210-016 must be thoroughly mixed at 70° to 95° F immediately before each application.

g. On painted surfaces, refinish as follows:

(1) Thoroughly mix and apply one coat of lacquer primer (MIL-P-11414) or zinc chromate primer (MIL-P-8585, color Y).

(2) Thoroughly mix and apply 2 coats of orange-yellow gloss enamel (Federal Specification TT-E-489), color 13538 (Federal Standard 595), or match existing color in surrounding area.

1-48. REMOVING CORROSION FROM CORROSION-RESISTANT STEEL, NICKEL, AND NICKEL ALLOYS.

1-49. Remove corrosion from CRES, nickel, and nickel alloys as follows:

a. Clean area in accordance with instructions in paragraph 1-44.

b. On small or complex components, clean corroded area with stainless-steel wool or 400-grit Carborundum paper until no corrosion is visible.

CAUTION

Vigorous, heavy, continuous rubbing of CRES by a power-driven wire brush can generate enough heat to cause metallurgical changes. Use care to avoid damage to equipment.

c. On large components and heavy equipment use a stainless-steel wire brush or a power-driven stainless-steel brush attachment to remove surface corrosion deposits.

d. Wipe surface with clean cloth dampened with distilled or deionized water.

e. Inspect area for corrosion with a 4-power monocular magnifier. If all corrosion has not been removed, repeat steps b or c and d

1-50. REMOVING CORROSION FROM CADMIUM-PLATED, CHROME-PLATED, NICKEL-PLATED, AND SILVER-PLATED PARTS.

1-51. When a plated surface has become pitted and pitting is not restricted to small areas, the part or component must be replaced or refinished. The acceptability and repair requirements are to be specified by the manufacturer's representative. For corrosion and small pitted areas, perform the following:

a. Clean area in accordance with instructions in paragraph 1-44.

b. Remove corrosion from plated surface using a wire brush and wool made of same material as base metal or 400-grit Carborundum paper.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Rinse area with trichloroethylene (MIL-T-27602) and wipe dry.

d. Inspect area for corrosion with a 4-power monocular magnifier. If all corrosion has not been removed, repeat steps b and c.

e. Apply a thin, even coat of preservative WD-40 (Rocket Chemical Co) to plated surface. Do not apply more than one coat.

1-52. REMOVING CORROSION FROM ALUMINUM ALLOYS.

1-53. Remove corrosion from aluminum alloy as follows:

a. Clean painted or unpainted aluminum alloy surfaces in accordance with instructions in paragraph 1-44.

b. Remove paint, if necessary, in accordance with instructions in paragraph 1-42.

CAUTION

When abrading clad aluminum, extreme care must be used not to rub through the pure aluminum coat. Without clad coating, some aluminum alloys corrode quickly.

c. Remove all corrosion products using aluminum wool or 400-grit Carborundum paper.

d. Rinse with distilled or deionized water and wipe dry.

e. Inspect area for corrosion with 4-power monocular magnifier. If all corrosion has not been removed, repeat steps c and d.

f. After removing corrosion, refinish surfaces that are to remain unpainted as follows:

(1) Clean area with TEC 901 (TEC Chemical Co).

(2) Clean area with distilled water. Do not wipe dry.

NOTE

Chemical film solution must be mixed with distilled or deionized water in accordance with manufacturer's instructions.

(3) While surface is still damp, apply chemical film (MIL-C-5541) with a clean brush.

(4) Keep area wet with fresh solution for 15-20 minutes.

(5) Rinse area with distilled water. Dry area with dry nitrogen (1-3 psi) or allow to air-dry. Do not wipe dry.

g. On surfaces to be painted, if required, apply zinc chromate primer (MIL-P-8585, color Y) and 2 coats of orange-yellow gloss enamel (Federal Specification TT-E-489), color 13538 (Federal Standard 595). Thoroughly mix both primer and enamel before use.

1-54. CLEANING.

1-55. All control assemblies, tubing, hoses, and tools that are installed in, or will come into contact with a propellant, hydraulic, or pneumatic system must be cleaned in accordance with the requirements of Marshall Space Flight Center Specification 104. Components, parts, or equipment removed from a clean system and handled in accordance with the contamination prevention requirements outlined in this manual may be reinstalled without additional cleaning. Lightly soiled parts may be used if cleaned using the specified procedures in applicable paragraphs 1-56 through 1-68 and found acceptable when visually inspected in accordance with paragraph 1-72. Before removing a component or part from a system, the surrounding area must be cleaned as follows:

NOTE

Lightly soiled parts are defined as parts that since being cleaned for propellant, pneumatic, or hydraulic service have been exposed to the atmosphere, inadvertently touched by a bare but otherwise clean hand, and/or have come in contact with parts that are not cleaned for the services noted, but are visually clean.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

a. Blow area free of loose contaminants with a regulated source of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) or clean, dry air that conforms to the cleanness and humidity requirements of MIL-P-27401.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Wipe area free of visible contaminants with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

1-56. CLEANING METAL PARTS.

1-57. Clean lightly soiled metal parts in accordance with steps a through c. Clean all other metal parts in accordance with steps a, b, d, and e.

a. During this procedure, observe safety precautions in paragraph 1-2.

b. Wear polyethylene gloves during cleaning operations. Rubber or neoprene gloves must not be worn, since cleaning solvents dissolve these materials and leave a contaminating residue on the surface of the part.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

c. Lightly soiled parts may be cleaned by handwiping and flushing with trichloroethylene (MIL-P-27602) or cleaning compound (MIL-C-81302). Dry parts. (Refer to paragraph 1-70 for drying procedure.)

d. Parts that do not come into contact with a propellant, pneumatic, or hydraulic system, either directly or indirectly, may be cleaned as follows:

(1) Prepare a solution of 7-8 ounces of Oakite No. 61B (Oakite Products, Inc) per gallon of water and heat to 120° to 160° F.

(2) Immerse parts in solution. Do not allow parts to remain immersed over 10 minutes.

(3) Immersion-rinse parts in water heated to 130° to 160° F.

(4) Spray-rinse parts with water. Use care to thoroughly rinse crevices and areas where cleaning solution could be trapped.

(5) Dry parts. (Refer to paragraph 1-70 for drying procedure.)

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

e. Clean exterior and interior surfaces of handling equipment, test equipment, and test consoles and panels containing dust or dirt with a clean, lint-free cloth. Clean surfaces containing oil or grease with a clean lint-free cloth moistened with drycleaning solvent (Federal Specification P-D-680, Type I), and wipe dry with a clean, lint-free cloth.

f. Package cleaned parts that are not to be immediately assembled. (Refer to paragraph 1-74.)

1-58. CLEANING NONMETAL PARTS.

1-59. Clean nonmetal parts, fabric material, and streamers as follows:

a. During this procedure, observe safety precautions in paragraph 1-2.

b. Wear polyethylene gloves during cleaning operations specified in step c. Rubber or neoprene gloves must not be worn, since cleaning solvents dissolve these materials and leave a contaminating residue on the surface of the part.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

- The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Clean lightly soiled nonmetal parts and all other nonmetal parts (except fabric material and streamers) by handwiping with a clean nylon

or lint-free cloth or by scrubbing with a clean nylon-bristle brush dampened with cleaning compound (MIL-C-81302) or trichloroethylene MIL-T-27602).

d. Dry parts. (Refer to paragraph 1-70 for drying procedure.)

e. Clean fabric material and streamers by immersing in an agitated solution of 4 ounces of additive 4215 (Turco Products), or equivalent, for each gallon of water heated to 130° ±10° F. Immersion-rinse in deionized water heated to 130° to 150° F for at least 2 minutes; then drip dry.

f. Package cleaned parts that are not to be immediately assembled. (Refer to paragraph 1-74.)

1-60. CLEANING COMBINATIONS OF METAL AND NONMETAL PARTS.

1-61. Parts that contain nonmetal items that are incompatible with the solvents used in this procedure must be treated as nonmetal parts (paragraph 1-58). If unable to determine compatibility of parts with solvents used in this procedure, contact manufacturer's representative for cleaning technique.

a. During this procedure, observe safety precautions in paragraph 1-2.

b. Wear polyethylene gloves during cleaning operations specified in step c. Rubber or neoprene gloves must not be worn, since cleaning solvents dissolve these materials and leave a contaminating residue on the surface of the part.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

● The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Clean lightly soiled parts by handwiping and flushing with trichloroethylene (MIL-T-27602) or cleaning compound (MIL-C-81302).

d. Dry parts. (Refer to paragraph 1-70 for drying procedure.)

e. Parts that do not come into contact with a propellant, pneumatic, or hydraulic system, either directly or indirectly, may be cleaned as outlined in steps f through j.

f. Immerse and rotate parts for 2 minutes in a solution of 4-6 ounces of mild alkaline cleaner RB0210-002 (Rocketdyne) to each gallon of water heated to 125° to 140° F.

g. Immersion-rinse a minimum of 2 minutes in deionized water heated to 130° to 160° F.

h. Rinse in deionized water for at least 2 minutes.

i. Dry parts. (Refer to paragraph 1-70 for drying procedure.) If an air-circulating oven is used, dry parts at 160° ±10° F for 3 hours.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

j. Final-rinse parts in cleaning compound (MIL-C-81302) for 2 minutes and repeat step i.

k. Package cleaned parts that are not to be immediately assembled. (Refer to paragraph 1-74.)

1-62. CLEANING WIRE MESH FILTERS.

1-63. The filter housing is cleaned as outlined in paragraph 1-56. The filter elements are ultrasonically cleaned as outline in this paragraph. The ultrasonic generator and transducer must be capable of 15-40 kHz (kilocycles per second), 5 watts per square inch minimum and 7.5 watts per square inch maximum (calculated)

power input for particle counting, and 3 watts per square inch minimum power input for cleaning. The power of the unit (input into tank) may be calculated as follows:

$$\frac{\text{Name tag rating of generator}}{\text{Tank surface area (in}^2\text{)}} = \text{Number of watts/in}^2$$

All equipment used during the cleaning process must be clean and a cleanness check made (steps a through c) before starting the cleaning operation.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

a. Pass 2,000 ±200 milliliters of 0.45-micron-filtered trichloroethylene (MIL-T-27602) through equipment, and collect sample in a clean container.

b. Filter collected sample through a black 0.45-micron filter disk for particle counting. Do not disrupt particle distribution on disk.

c. Count particles. Maximum number of particles larger than 50 microns must not exceed 100. If particles count exceeds this limit, repeat steps a and b until within accepted limit.

d. Install filter in ultrasonic unit so that fluid will pass through filter in opposite direction of designed flow.

e. Turn on ultrasonic unit and adjust to 15-40 kHz.

f. After 1 ±0.25 minutes, pass 500 ±25 milliliters of clean fluid through filter.

g. Repeat step f at 4, 7, and 9 ±0.25 minutes and turn ultrasonic unit off. Dispose of backflush fluid. Fluid level in filter container must remain relatively constant at a point near filter collar.

h. Repeat steps e through g 2 times.

i. Install filter in ultrasonic unit so that fluid will pass through filter in designed direction of flow.

j. Repeat steps a through c. Turn on ultrasonic unit and adjust to 15-40 kHz.

k. After 1, 4, 7, and 9 ±0.25 minutes, pass 500 ±25 milliliters of clean trichloroethylene (MIL-T-27602) through filter and collect fluid in clean container. Fluid level in filter container must remain relatively constant at a point near filter collar.

l. Filter 2,000-milliliter sample through a black 0.45-micron membrane disk, rinsing collection container with a like quantity of 0.45-micron-filtered trichloroethylene (MIL-T-27602) when approximately 25 milliliters of sample fluid remains to be filtered. Do not disrupt particle distribution on disk.

m. Count all particles on effective filter disk area that are 50 microns or over. Do not differentiate between a particle and a fiber. Tabulate particles into two groups, 50-100 microns and over 100 microns. Counts exceeding 1,000 particles in 50-100 micron range or 200 particles in over 100-micron range, requires recleaning of filter.

n. Dry filter. Air-dry, using paragraph 1-70 procedures, except gaseous nitrogen or air must be filtered (25-micron absolute or better), or dry filter in oven at 200° ±10° F for a minimum of 30 minutes.

o. Package cleaned filters that are not to be immediately assembled. (Refer to paragraph 1-74.)

1-64. CLEANING ELECTRICAL COMPONENTS.

1-65. Clean electrical components as follows:

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

a. Remove dust, dirt, and foreign matter from electrical components with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) or clean, dry air that conforms to the cleanness and humidity requirements of MIL-P-27401.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Remove stains, grease, and foreign materials from exterior surfaces of cables by brushing with a soft-bristle brush or by wiping with a clean, lint-free cloth dampened (not saturated) with methyl-ethyl-ketone (Federal Specification TT-M-261). Do not allow methyl-ethyl-ketone to contact inner surfaces of connectors.

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

c. Clean interior and exterior surfaces of connectors by brushing lightly with a cotton swab or a soft-bristle brush dipped in isopropyl alcohol (Federal Specification TT-I-735).

d. Immediately blow connector dry. (Refer to paragraph 1-70 for drying procedure.)

e. Install protective closure on connector unless connector is to be connected immediately.

1-66. CLEANING BURST DIAPHRAGM ASSEMBLIES.

1-67. Clean burst diaphragms as follows:

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

CAUTION

The diaphragm disk is fragile. Probing, rubbing, brushing, or applying pressurized gas can damage the diaphragm disk.

a. Clean burst diaphragms with cleaning compound (MIL-C-81302). The burst diaphragm is not to be disassembled for cleaning. Do not probe, wipe, brush, or otherwise contact interior surfaces. Clean interior surfaces by hand-agitating the diaphragm in cleaning compound.

b. Air-dry assembly before use or packaging; do not use pressurized gas.

1-68. CLEANING PRESSURE TRANSDUCERS.

1-69. Pressure transducers are delicate instruments and must be handled with extreme care. Solid material must not be inserted in the sensing cavity. Cleaning solution temperatures must not exceed 165° F. Clean pressure transducers as follows:

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

a. Clean exterior surfaces of connector by brushing lightly with a natural-fiber brush dipped in isopropyl alcohol (Federal Specification TT-I-735). Install protective cap.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

b. Clean exterior surface of transducer by handwiping with a clean, lint-free cloth moistened in cleaning compound (MIL-C-81302).

c. Flush sensing port with cleaning compound (MIL-C-81302).

CAUTION

The tube used to flush or rinse the sensing cavity must not be inserted more than 1/4 inch.

d. Rinse transducer in cleaning compound (MIL-C-81302).

e. Immediately dry transducer. (Refer to paragraph 1-70 for drying procedure.)

1-70. DRYING CLEANED PARTS.

1-71. Immediately after cleaning, parts must be thoroughly dried to remove the cleaning solution and remaining moisture. Unless otherwise specified, dry parts as follows:

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

a. Observe facility safety requirements.

b. Thoroughly dry parts with a regulated source of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) or clean, dry air that conforms to the cleanness and humidity requirements of MIL-P-27401, or dry parts in an air-circulating oven at a temperature of 250° ±10° F for one hour (or as specified in applicable maintenance procedure). Apply gaseous nitrogen or air only to surface area to be dried and in a direction away from the body and other personnel.

1-72. INSPECTING FOR CLEANNESS.

1-73. Inspect parts for moisture, rust, scale, dirt, chips, oil, grease, or other foreign materials that require recleaning of parts. Discoloration caused by welding or passivation is not considered grounds for recleaning unless accompanied by rust or scale.

1-74. HANDLING AND PACKAGING CLEAN PARTS.

1-75. Improper handling of clean parts during removal and installation procedures, or after cleaning, can result in unnecessary expenditure

of time and effort to reclean parts. It is recommended that clean parts be handled and packaged as follows:

a. Wear clean nylon gloves No. 7862 (Victor Gloves, Inc) or disposable polyethylene gloves where hand contact is made with surfaces that will contact operating fluids (liquid or gas).

b. Upon removal of clean parts or upon completion of cleaning procedure, immediately install suitable closures or covers to prevent contamination of part or damage to sealing surfaces.

c. Package parts, except when parts are to be assembled, as follows:

(1) Package small, lightweight parts that have external or exposed surfaces that come in contact, directly or indirectly, with propellant, pneumatic, or hydraulic systems, in a clean vinyl or polyethylene (0.004 inch minimum) bag, and heat-seal bag. If part weighs more than 3 pounds, use bags with a minimum wall thickness of 0.006 inch. If part has sharp projections, use 2 bags, one inside the other, to minimize possibility of puncture. If this method is inadequate, use an initial wrap of several layers of polyethylene film instead of inner bag.

(2) Seal decals or labels to plastic bag during sealing operation.

(3) For parts with such shape, fragility, finish, or weight that packaging instructions in substep 1 are inadequate, additionally wrap parts in polyurethane or polyethylene foam. For parts weighing less than 7 pounds, the minimum thickness of the polyurethane foam must be 1/2 inch, and for parts weighing 7-10 pounds, one inch. If polyethylene foam is used, the minimum thickness used must be 1/8 inch for parts less than 7 pounds, 1/4 inch for parts weighing 7-10 pounds, 3/8 inch for parts weighing 10-15 pounds, and 1/2 inch for parts weighing 15-20 pounds.

(4) Pack parts in a suitable, snug-fitting container marked with same information as on part except serial number.

(5) Certify cleanness; identify all parts as to specific service with appropriate seals, labels, or decals. Seals, labels, or decals must not be applied to surfaces that will be in contact with the propellants or pneumatic gases, machined surfaces, or sealing surfaces.

(6) Identify parts that have been lubricated for a specific service, with appropriate labels or decals.

(7) For parts packaged in cartons, certify that part has been cleaned and properly packaged by marking specific service on exterior of package.

1-76. INSPECTING PARTS FOR DAMAGE.

1-77. Several test methods may be used to determine if parts are damaged. Visual inspection is normally a satisfactory method for determining damage. For parts where damage is suspected but not apparent, however, the dye-penetrant or magnetic-particle inspection methods may be used, as applicable. If inspection of a component or part reveals a defect that does not have an acceptability or repair disposition within this manual, the defect must be referred to the manufacturer's representative for acceptability and repair disposition.

1-78. VISUAL INSPECTION.

1-79. Visually inspect part for damage as follows:

a. Threaded inserts for loose inserts, damaged threads, and correct installation depth.

b. Tapped threads for damaged threads. Threads in parent metal must be inspected if the insert is removed.

c. Electrical connectors for fungus, loose and damaged pins, and stripped, burred, and crossed threads; cables for fraying.

d. Dynamic and static sealing surfaces for nicks, burs, and scratches that could impair sealing function.

e. Anodic-coated surfaces for worn or damaged coating.

f. Evidence of corrosion, distortion, or cracked welds.

1-80. DYE-PENETRANT INSPECTION.

1-81. The dye-penetrant inspection method is used for parts treated by chemical film or anodic coatings and parts used for indirect liquid oxygen service. This method of inspection may be used to detect surface defects or indications of possible defects in parts made of nonabsorbent, nonporous material. Dye-penetrant indications are not necessarily cause for rejection. It is the responsibility of a dye-penetrant inspector, certified by MIL-STD-410, to evaluate indications and to determine whether an indication actually represents a defect. Perform the dye-penetrant inspection as follows:

a. Clean part (paragraph 1-54) using appropriate method for type of service in which part is used.

b. Brush or spray a light, even coat of SKL-4 dye-penetrant (Magnaflux Corp) on areas to be inspected.

c. Allow penetrant to remain on part for a minimum of 5 minutes at 60° to 90° F. Parts that have been in an environment of less than 60° F must be preheated to 60° to 150° F and allowed to remain at normal room temperature (60° to 90° F) for a minimum of 30 minutes before application of penetrant.

d. Remove excess penetrant with a clean, dry cloth followed by a water-dampened cloth.

e. Air-dry part for a minimum of one minute, or wipe part with clean, dry cloth or paper towel, before application of developer.

f. Thoroughly mix SKD-NF spot-check developer (Magnaflux Corp), and spray a thin, even coat on area to be inspected.

g. Wait a minimum of 5 minutes, and inspect area for defects.

h. Clean part after inspection using appropriate method for type of service in which part is used.

1-82. MAGNETIC PARTICLE INSPECTION.

1-83. Magnetic particle inspection is a nondestructive method used to detect cracks, laps, seams, nonmetallic inclusions, or other surface or subsurface discontinuities within 0.004 inch of the surface in ferromagnetic parts. When a part is magnetized by an electric current, a discontinuity that crosses the magnetic field creates magnetic poles on either side of the defect. When magnetic particles are applied to the part, the poles attract the particles and form an indication of the discontinuity. A magnetic particle inspection cannot be performed on aluminum, magnesium, brass, copper, bronze, lead, or titanium. Personnel performing magnetic particle inspections must be certified by MIL-STD-410. Perform inspection as follows:

a. Allow agitator system to circulate inspection medium for a minimum of 15 minutes before starting inspection operations.

b. Warm up black light on fluorescent magnetic particle equipment for a minimum of 15 minutes before using. A minimum of 125 foot-candles of illumination, at a distance of 15 inches from light source, is required.

c. Strip part if surface coating is greater than 0.003 inch thick.

d. Clean part, using appropriate method for type of service in which part is used.

e. Magnetize part in at least 2 directions.

f. Apply magnetic particles to part.

g. Following each magnetization, carefully examine part. The certified magnetic particle inspector must evaluate indications and determine whether an indication actually represents a defect.

h. Demagnetize part. Check part for residual magnetism with standard field indicator.

i. Clean part, using appropriate method for type of service in which part is used. All magnetic particles must be completely removed from part.

j. Reapply surface coating if coating was removed.

1-84. REPAIR.

1-85. Field repair of ground support equipment is authorized when such repair can correct the defect, has no detrimental effect on the safety or performance of the equipment, and has the

concurrence of Rocketdyne Engineering. A component or part that cannot be repaired must be replaced with a part bearing the same part number, or an approved alternate. If the tolerance for a part cannot be maintained after the removal of nicks, burs, or scratches, the part must be replaced. After repair, all parts must be cleaned, using the appropriate method for the type of service in which the part is used, before assembly and testing.

1-86. REPAIRING THREADS.

1-87. Threads may be repaired if total damage to threads does not exceed 50 percent of one thread. Threads that are considered repairable should be repaired with the correct-size tap or die. Replace parts whenever total thread damage exceeds 50 percent of one thread.

1-88. REPAIRING WELDS OR CRACKS.

1-89. Repair of part of component welds, parent metal cracks and distortion of part, or component surfaces other than specified within this manual, must be referred to the manufacturer's representative for acceptability and repair disposition.

1-90. REPAIRING DAMAGED SEALING SURFACES.

1-91. Field repair is authorized for damaged sealing surfaces that seal to an engine component flange. In each specific instance, contact the manufacturer's representative, who will determine disposition of damaged surfaces and provide applicable repair instructions.

1-92. REPAIRING CHEMICAL FILM.

1-93. Either Iridite 14-2 solution (Allied Research Products) (steps d and e) or Alodine 1200 (Amchem Products) may be used in applying chemical film touchup to parts after repair. Apply chemical film touchup as follows:

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

a. Clean part using trichloroethylene (MIL-T-27602), and wipe part dry with soft, clean cloth.

b. Wearing rubber gloves, deoxidize part by applying a mixture of one part by volume of cleaning compound (MIL-C-5410, Type II) and one part distilled or deionized water at 65° to 95° F. Use a soft-bristle brush or clean cloth to apply mixture, and keep surface wet for 5-10 minutes.

c. Using a spray, rinse part in clean tap water at room temperature, or wipe part with a clean cloth frequently wrung out in clean water.

WARNING

The following procedure specifies Iridite and Alodine solutions, which are acids. Contact with the solutions can cause serious injury to personnel or damage to equipment.

d. Prepare Iridite solution by mixing 6 ounces of Iridite 14-2 powder and 0.01 ounce of ARP No. 2 detergent (Allied Research Products) in one gallon of water.

WARNING

The following procedure specifies nitric acid, which must not be allowed to come in contact with any part of the body. Eye protection and protective clothing must be worn by personnel handling nitric acid. Spillage may cause fire. Nitric acid must be used in a well-ventilated area since the vapors are extremely hazardous. Inhalation of the vapors or contact with the liquid can cause serious injury or death. In case of contact, the skin or eyes must immediately be flushed with water for at least 15 minutes and given medical attention.

e. Prepare Alodine solution by mixing 4 ounces of Alodine 1200 powder (Amchem Products) with 0.5 ounce of nitric acid (Federal Specification O-N-350) in one gallon of water.

f. Wearing face shield and rubber gloves and using a soft-bristle brush or clean cloth, coat part with Iridite 14-2 solution for 3-5 minutes or coat part with Alodine 1200 solution for 1-3 minutes. Coat only a small area at a time. If no color develops, repeat steps b, c, and f.

g. Rinse part by flushing with tap water. Avoid hand-rubbing since wet film is easily removed.

WARNING

Organic material upon which Iridite or Alodine solutions have dried, becomes highly flammable and could result in injury to personnel.

h. Thoroughly rinse solution from brushes and cloths.

1-94. REPAIRING PAINTED SURFACES.

1-95. Painted areas that have been damaged by handling, rework, or corrosion removal must be touched up to eliminate all bare or worn spots as follows:

a. Using 400-grit Carborundum paper, feather edges of existing finish adjacent to damaged areas.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

b. Clean reworked and surrounding area with a clean cloth dampened with drycleaning solvent (Federal Specification P-D-680, Type I).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

c. Dry area with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) or air that conforms to the cleanness and humidity requirements of MIL-P-27401.

d. Within one hour after cleaning, prime area with a thin coat of zinc chromate primer (MIL-P-8585, color Y).

e. Mix thoroughly and apply one coat of enamel of specified type and color.

f. For lettering and other markings, apply one coat of black semigloss enamel (Federal Specification TT-E-529), color 27038 (Federal Standard 595). For warning notices use red gloss enamel (Federal Specification TT-E-489), color 11136 (Federal Standard 595).

1-96. REPASSIVATING 300-SERIES AND 400-SERIES CORROSION-RESISTANT STEEL.

1-97. Reworked areas on corrosion-resistant steels may be repassivated by swab passivation as described in the following steps. Parts brazed with silver, copper, or nickel alloys must not be passivated. Do not passivate Hastelloy B, 440A (annealed); Monel 440, 440B (annealed); Monel K-500, 440C (annealed); Nickel 200, 440F (annealed); or Nickel 201.

a. If area is corroded, remove corrosion as outlined in paragraph 1-48.

b. If scratched or abraded, brush area to be passivated with fine-wire stainless-steel brush.

c. Polish area with crocus cloth.

WARNING

The following procedure specifies trichlorcethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

d. Thoroughly clean area with a clean, hemmed nylon cloth dampened with clean trichloroethylene (MIL-T-27602),

trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302). Dry area. (Refer to paragraph 1-70 for drying procedures.)

WARNING

The following procedure specifies nitric acid, which must not be allowed to come in contact with any part of the body. Eye protection and protective clothing must be worn by personnel handling nitric acid. Spillage may cause fire. Nitric acid must be used in a well-ventilated area since the vapors are extremely hazardous. Inhalation of the vapors or contact with the liquid can cause serious injury or death. In case of contact, the skin or eyes must immediately be flushed with water for at least 15 minutes and given medical attention.

e. Prepare a 40-50 percent, by volume, solution of nitric acid (Federal Specification O-N-350) and distilled or deionized water. Slowly pour acid into required amount of water.

f. Using a cotton swab, passivate area by swabbing with nitric acid solution at 10-minute intervals for a minimum of 60 minutes. If necessary, provide a barrier to prevent solution from dripping on other equipment.

g. Thoroughly rinse cotton swab and area with tap water.

h. Final-rinse area with deionized or distilled water.

i. Dry area with clean, dry cloth.

1-98. REPAIRING MICROSOL PROTECTIVE COATINGS.

1-99. Repair consists of removing damaged coating (where damaged area exceeds approximately 2 sq in.) and installing two or more layers of polyvinyl tape. (Repair of smaller areas is not required.)

a. Remove Microsol coating from damaged area by scraping with a knife. Where entire coating installation is not being removed for repair, trim and taper edges of remaining coating to provide a neat appearance to finished repair.

b. Sand the scraped area with abrasive cloth, 250-grit or finer. Thorough sanding of area is not required except as necessary to provide a smooth, clean surface for tape application. Minor abrading of anodic coating is acceptable.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

c. Remove sanding debris by wiping repair area and surrounding areas as necessary with a clean cloth moistened with drycleaning solvent (Federal Specification P-D-680, Type I or II), or equivalent; then wipe surfaces dry.

d. Apply 2 layers (minimum) of white or black polyvinyl tape P32 (Johnson and Johnson, Inc) or a polyvinyl tape of equivalent thickness. (Use white tape with white Microsol, and black tape with black Microsol.) Tape must be applied carefully to provide a neat, finished appearance. Make sure tape adheres securely to cleaned surface. Overlapping of tape and of adjacent Microsol coating is permissible. Tape may be removed and replaced to provide a neat appearance and maximum protection to engine components.

1-100. APPLYING LUBRICANTS, SEALANTS, AND COMPOUNDS.

1-101. Lubricants, sealants, and compounds that are contaminated, whose shelf life has expired, or whose container labels are missing or unidentifiable must not be used. Clean nylon or polyethylene gloves must be worn where hand contact is made with sealing surfaces or surfaces that contact operating fluids (liquid or gas). Parts that will be reinstalled must have the original lubricant, sealant, or compound removed from the part and mating surfaces before lubricating. Lubricants, sealants, and compounds must be applied only to the areas designated. All stored containers must be tightly capped, and excess lubricant, sealants, or compounds must not be returned to the original container. All lubricants, sealants, and compounds must be free of grit, dirt, metal chips, and other foreign matter. The methods outlined below, which will be referenced in the applicable procedures, must be used to apply lubricants, sealants, and compounds. The following definitions apply to these methods:

a. O-Ring: A circular packing, gasket, or seal having a torus or doughnut shape. The O-ring cross section is usually round and has a small diameter relative to the inside and outside diameter of the O-ring.

b. Seal: Any sealing device other than an O-ring.

c. Static Condition: When an installed part encounters no movement except for vibrational or load forces.

d. Dynamic Condition: When an installed part encounters planned movement.

NOTE

Only the lubrication methods used in this manual (Volumes I and II) are listed.

1-102. METHOD A - APPLYING LUBRICANT TO STRAIGHT THREADS (STATIC CONDITION).

a. Apply lubricant in a streak, flush with outside peaks of male threads, and across all threads except leading edge of first thread.

NOTE

The number and width of streaks vary with the outside diameter of threads.

b. Where more than one application is required, apply lubricant in equally spaced streaks around circumference of threads as follows:

(1) Threads up to 1/2 inch in diameter, one application 1/8 to 1/4 inch wide.

(2) Threads 1/2 to 1 inch in diameter, one application 3/8 inch wide.

(3) Threads 1 to 1-3/4 inches in diameter, two applications 1/2 inch wide.

(4) Threads 1-3/4 to 2-1/2 inches in diameter, three applications 1/2 inch wide.

(5) Threads 2-1/2 to 3 inches in diameter, four applications 1/2 inch wide.

(6) Threads over 3 inches in diameter, five applications 1/2 inch wide.

c. Distribute lubricant streaks uniformly around threads with a clean nylon brush. Remove excess lubricant. Make sure there is no lubricant on leading edge of first thread, in fitting openings, or on flared or chamfered sealing surfaces.

1-103. METHOD C - APPLYING LUBRICANT TO STRAIGHT THREADS (DYNAMIC CONDITION).

a. Use a clean nylon cloth and remove any existing lubricant from threads.

b. Apply lubricant in a streak, flush with outside peaks of male threads, and across all threads except edge of first thread.

NOTE

The number and width of streaks vary with the outside diameter of threads.

c. When more than one application is required, apply lubricant in equally spaced streaks around circumference of threads as follows:

(1) Threads up to 1/2 inch in diameter, one application 1/8 to 1/4 inch wide.

(2) Threads 1/2 to 1 inch in diameter, one application 3/8 inch wide.

(3) Threads 1 to 1-3/4 inches in diameter, two applications 1/2 inch wide.

(4) Threads 1-3/4 to 2-1/2 inches in diameter, three applications 1/2 inch wide.

(5) Threads 2-1/2 to 3 inches in diameter, four applications 1/2 inch wide.

(6) Threads over 3 inches in diameter, five applications 1/2 inch wide.

d. Distribute lubricant streaks uniformly around threads with a clean nylon brush. Make sure there is no lubricant on leading edge of first thread, in fitting openings, or on flared or chamfered sealing surfaces.

1-104. METHOD G - APPLYING LUBRICANT TO TUBE COUPLING NUTS.

a. Slide coupling nut back on tube and remove any existing lubricant with a clean nylon cloth.

b. Apply a thin uniform film of lubricant to exterior thrust surface of sleeve or machined seat as shown in figure 1-5.

c. Remove all excess lubricant from end face and sealing surface of flare, to prevent contamination of system.

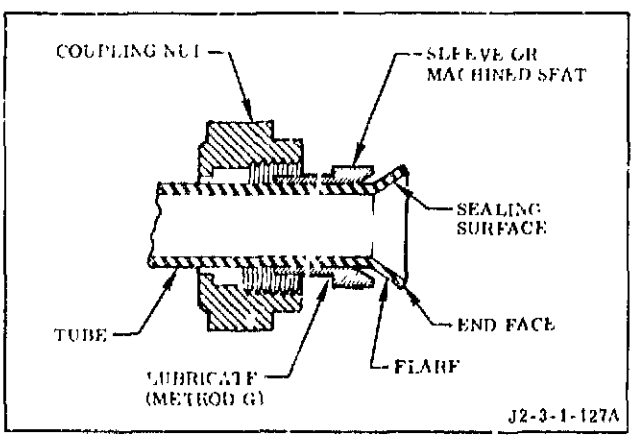


Figure 1-5. Applying Lubricant to Tube Coupling Nut Sleeves

1-105. METHOD I - APPLYING THREAD SEALANT TAPE.

a. Apply thread sealant tape RB0140-002 (Rocketdyne) around external threads in the direction for loosening. Stretch tape slightly to conform tape to threads. Do not apply tape to engaging thread at end of fastener.

b. Overlap starting turn of tape by approximately 1/2 inch and break tape. If width of threads is one inch or more, use 2 identical wrappings side by side.

1-106. METHOD J - APPLYING LUBRICANT TO O-RINGS (STATIC CONDITION).

a. Distribute lubricant over O-ring surface to form a thin, uniform film.

b. Remove excess lubricant.

1-107. METHOD L - APPLYING LUBRICANT TO O-RINGS (DYNAMIC CONDITION).

a. Apply a thin, uniform film of lubricant on O-ring surface. Remove excess lubricant.

b. Apply a volume of lubricant approximating 25-30 percent of O-ring volume or groove volume on O-ring or in groove during installation of O-ring. Apply excess to dynamic surface mating with O-ring, to form a uniform film.

c. Apply additional lubricant, if required, to mating surface to provide a thin, uniform film over the working surface. Remove excess lubricant from mating surface.

1-108. METHOD W - APPLYING LUBRICANT TO PLAIN BEARING (SLIDING) SURFACES.

a. Apply lubricant to part during installation, or pack clearance volume during assembly.

b. Remove excess lubricant by wiping.

1-109. METHOD X - APPLYING LUBRICANTS WITH GREASE GUN.

CAUTION

Caution must be used when lubricating parts containing positive grease seals to prevent damage to seals.

a. Wipe grease fittings clean before lubricating.

b. Attach grease gun to fitting and inject lubricant until it extrudes between bearing surfaces.

c. Remove extruded lubricant, and lubricant from fittings.

1-109A. METHOD Z - APPLYING LUBRICANTS TO METAL SLIDING SURFACES.

a. Using a clean nylon cloth, remove any existing lubricant from mating parts.

b. Apply a uniform coat of lubricant to mating parts.

c. Assemble parts and remove excess lubricant. Make sure that lubricant does not enter vent, pilot, or bleed openings.

1-110. APPLYING LUBRICANT TO BALL-LOCK PINS. Lubricating ball-lock pins consists of removing existing lubricant, cleaning, and lubricating, as follows:

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

• The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

a. Immerse shank of ball-lock pin in clean trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302), and actuate ball-lock pin release until existing lubricant is flushed out.

b. While actuating ball-lock pin release, allow cleaning agent to drain from lockpin. Allow lockpin to dry thoroughly.

c. Force lubricant into ball-lock pin at shank end and around ball-locks while actuating ball-lock pin release.

d. Wipe grease from exterior surfaces of ball-lock pin.

1-111. INSTALLING THREADED FASTENERS.

1-112. During maintenance and repair, the installation of threaded fasteners is governed by the following general requirements:

a. Structural bolts or screws one dash number above that called out may be used to join pressurized or load-carrying components provided that the thickness of the joint-thinner flange at the bolthole location is 0.125 inch or greater.

b. For structural joints (load carrying or pressurized), additional washers of the same callout may be added up to a total added thickness of 10 percent of the thinner flange, at the bolthole location.

c. Deviation of bolt-length dash numbers and the number of washers used in steps a and b is not permitted for bolts and screws used with screw-thread inserts.

d. For nonstructural applications, bolts or screws three dash numbers above or below those called out may be used if there is full thread engagement (fastener penetrates full length of perfect threads) and no interference occurs.

e. Single washers, except countersunk washers, are installed at the nut end; however, when more than one is specified, the washers must be evenly divided between the head and nut ends of the bolt.

f. It is desirable that no threads be in bearing in any part of a joint where the threaded fasteners transmit a shear load. However, if unavoidable, a maximum of two threads may be in bearing if the material next to the nut meets the minimum thickness requirements given in figure 1-6. Parts having relative movement at the fastener must not have threads in bearing.

g. Bolts used with self-locking nuts or inserts must not have cotter pin holes in the threaded shank.

h. Threaded parts must not be lubricated unless all of the following conditions prevail:

(1) Both parts are bare, corrosion-resistant steel.

Material Next to Nut			Number of Threads in Bearing	Minimum Material Thickness (Inch) Next to Nut For Standard Fasteners Having a Tensile Strength of 125,000-140,000 PSI									Minimum Material Thickness (Inch) Next to Nut For High-Strength Fasteners Having a Tensile Strength of 160,000 PSI and Over							
				Fastener Size (Inch)									Fastener Size (Inch)							
				No. 10, 3 16	1/4	5 16	3 8	7 16	1 2	9 16	5 8	3 4	1 4	5 16	3 8	7 16	1 2	9 16	5 8	3 4
Aluminum Alloy	Sheet and Tubing	Alclad 2024-T4	1	0.156	0.250	0.250	0.312	0.375	0.375	0.438	0.500	0.625	0.250	0.312	0.375	0.438	0.500	0.625	0.625	0.750
			2	0.250	0.312	0.375	0.375	0.438	0.438	0.500	0.625	0.625	0.312	0.375	0.438	0.500	0.625	0.625	0.625	0.750
		7075-T6	1	0.125	0.156	0.188	0.250	0.250	0.312	0.312	0.375	0.438	0.188	0.250	0.250	0.312	0.375	0.375	0.438	0.500
			2	0.250	0.312	0.375	0.375	0.438	0.438	0.500	0.500	0.500	0.312	0.375	0.375	0.438	0.438	0.500	0.500	0.625
		Bare 2024-T4	1	0.156	0.250	0.250	0.312	0.375	0.375	0.438	0.500	0.625	0.250	0.312	0.375	0.438	0.438	0.500	0.625	0.750
			2	0.250	0.312	0.375	0.375	0.438	0.438	0.500	0.500	0.625	0.312	0.375	0.375	0.500	0.500	0.625	0.625	0.750
		7075-T6	1	0.125	0.156	0.188	0.250	0.250	0.250	0.312	0.312	0.375	0.188	0.250	0.250	0.312	0.312	0.375	0.375	0.438
			2	0.250	0.312	0.375	0.375	0.438	0.438	0.500	0.500	0.500	0.312	0.375	0.375	0.438	0.438	0.500	0.500	0.500
	Bar and Extrusion	2014-T6	1	0.129	0.163	0.201	0.232	0.272	0.304	0.343	0.373	0.444	0.196	0.244	0.283	0.332	0.372	0.418	0.458	0.545
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.506	0.286	0.334	0.334	0.400	0.422	0.473	0.513	0.607
		2024-T4	1	0.153	0.197	0.243	0.283	0.331	0.371	0.419	0.459	0.546	0.250	0.312	0.375	0.438	0.500	0.625	0.625	0.750
			2	0.250	0.286	0.334	0.334	0.400	0.421	0.414	0.514	0.608	0.312	0.375	0.438	0.500	0.625	0.625	0.625	0.750
		7075-T6	1	0.125	0.151	0.186	0.215	0.251	0.280	0.316	0.344	0.408	0.181	0.225	0.261	0.306	0.342	0.384	0.421	0.500
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.476	0.562
	Forgings	2014-T6	1	0.125	0.159	0.195	0.226	0.264	0.295	0.333	0.363	0.431	0.191	0.236	0.275	0.322	0.361	0.406	0.455	0.529
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.411	0.461	0.500	0.591
		7075-T6	1	0.125	0.151	0.186	0.215	0.251	0.280	0.316	0.344	0.408	0.181	0.225	0.261	0.306	0.342	0.384	0.421	0.500
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.476	0.562
	Castings	195-T6, 356-T6	1	0.217	0.281	0.349	0.410	0.479	0.540	0.610	0.669	0.800	0.346	0.432	0.509	0.595	0.672	0.755	0.833	0.996
			2	0.250	0.316	0.390	0.451	0.529	0.590	0.665	0.724	0.862	0.381	0.473	0.550	0.645	0.722	0.810	0.888	1.058
		220-T4	1	0.201	0.259	0.321	0.377	0.440	0.496	0.560	0.614	0.733	0.318	0.396	0.467	0.546	0.616	0.692	0.763	0.911
			2	0.250	0.294	0.362	0.418	0.490	0.546	0.615	0.669	0.795	0.353	0.437	0.508	0.596	0.666	0.747	0.818	0.973
Magnesium	Castings	Heat-treated	1	0.255	0.330	0.410	0.484	0.564	0.638	0.721	0.792	0.947	0.408	0.509	0.603	0.703	0.796	0.895	0.989	1.182
			2	0.287	0.365	0.451	0.525	0.614	0.688	0.776	0.847	1.009	0.443	0.550	0.644	0.573	0.846	0.950	1.044	1.244
		Heat-treated and aged	1	0.238	0.309	0.383	0.451	0.527	0.595	0.671	0.738	0.882	0.381	0.475	0.561	0.656	0.741	0.832	0.920	1.099
			2	0.270	0.344	0.424	0.492	0.577	0.645	0.726	0.793	0.944	0.416	0.516	0.602	0.706	0.791	0.887	0.975	1.161
Steel	1020 or equiv		1	0.155	0.200	0.246	0.287	0.336	0.377	0.426	0.465	0.554	0.243	0.301	0.353	0.414	0.465	0.523	0.574	0.684
			2	0.250	0.286	0.334	0.334	0.400	0.427	0.481	0.520	0.616	0.286	0.342	0.394	0.464	0.515	0.578	0.629	0.746
	4130, 4140, 4340, 8735, 8740, or equiv	Normalized	1	0.125	0.143	0.173	0.200	0.234	0.260	0.294	0.319	0.379	0.169	0.208	0.242	0.284	0.316	0.356	0.389	0.463
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.525
		Heat-treated to 125,000 psi min	1	0.125	0.143	0.167	0.168	0.200	0.218	0.246	0.267	0.316	0.143	0.175	0.202	0.237	0.263	0.296	0.323	0.383
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500
		Heat-treated to 140,000 psi min	1	0.125	0.143	0.167	0.167	0.200	0.210	0.237	0.256	0.303	0.143	0.169	0.194	0.228	0.253	0.284	0.310	0.367
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500
		Heat-treated to 160,000 psi min	1	0.125	0.143	0.167	0.167	0.200	0.202	0.228	0.247	0.292	0.143	0.167	0.187	0.219	0.243	0.273	0.298	0.353
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500
		Heat-treated to 180,000 psi min	1	0.125	0.143	0.167	0.167	0.200	0.200	0.222	0.240	0.284	0.143	0.167	0.182	0.214	0.237	0.266	0.289	0.343
			2	0.250	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500	0.286	0.334	0.334	0.400	0.400	0.444	0.444	0.500

Figure 1-6. Minimum Material Thickness Next to Nut for Threaded Fasteners Having Threads in Bearing

(2) A lubricant for the service encountered is specified.

(3) A specific torque value is given.

i. Torquing of fasteners is performed by applying specified torque to the fastener. Fastener groups utilize the cross-torque method outlined in paragraph 1-128.

j. When a fastener is installed in a nut (except castellated nuts), at least one full thread must protrude through the top of the nut. Fasteners installed in inserts must penetrate the full length of the perfect threads of the insert.

1-113. INSTALLING COUNTERSUNK HIGH-STRENGTH AND HIGH-BEARING WASHERS.

1-114. Whenever countersunk washers RD153-5003-XXXX or MS20002 are required, the washer countersunk side must be installed adjacent to the bolt fillet radii. Where requirements are for 2 washers, the second washer must be installed under the nut. Figure 1-7 shows a high-tensile-strength bolt and nut installation using countersunk, high-bearing washers.

1-115. REMOVING AND INSTALLING INSERTS AND STUDS.

1-116. These procedures consist of removing and installing inserts and studs. The Keenserts inserts and studs, heli-coil inserts, and Rosan inserts may be removed and replaced if damaged. The same size replacement insert or stud is installed in the undamaged, original tapped hole.

1-117. REMOVING KEENSERTS INSERTS AND STUDS. To remove a Keensert insert, drill to diameter and depth indicated in Removal Data columns of figure 1-8. Deflect exposed portion of Kees inwardly and break off. Drive in E-Z Out extraction tool and back out insert. (See figure 1-9.) To remove a Keensert stud, cut stud just above surface of parent material and remove remainder by drilling as for an insert.

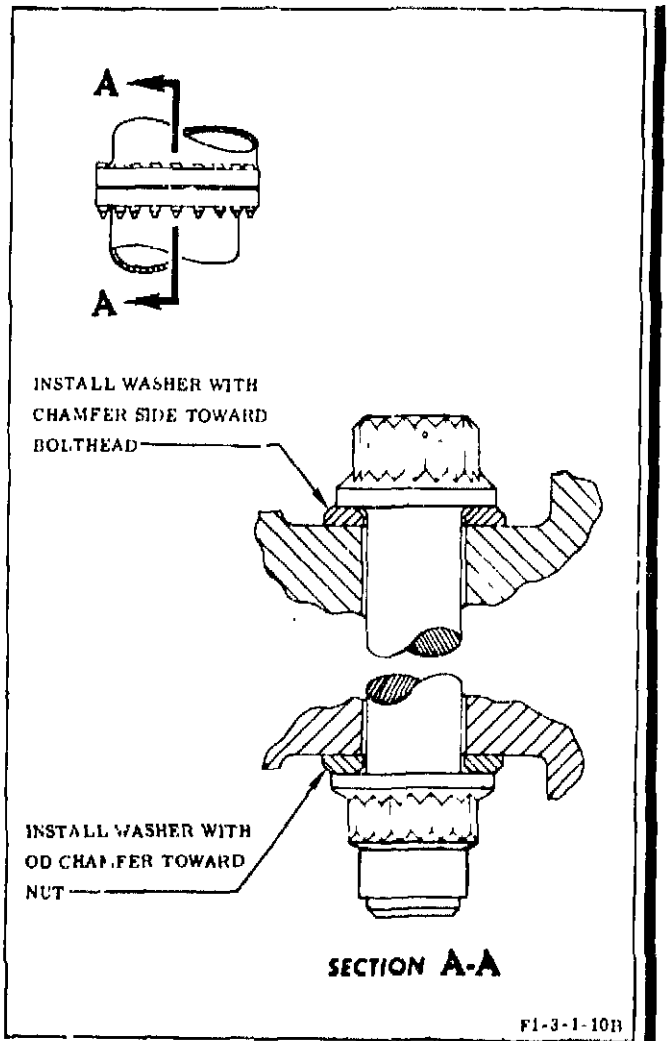


Figure 1-7. Installing Countersunk High-Strength and High-Bearing Washers

1-118. INSTALLING KEENSERTS INSERTS.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

a. Clean all applicable parts to meet cleanness requirements of engine system to which part is designed to be attached.

b. Select correct replacement insert. See figure 1-8 for tap size and installing tool for insert selected.

c. If necessary, chase threads to remove burs.

d. Clean tapped hole to remove all chips.

e. Install insert by turning with fingers, or fit Kees into tool slots and turn tool. (See figure 1-9.)

f. Install insert to a depth of 0.010 to 0.030 inch below surface of parent metal. Aline insert Kees with original slots in parent metal. If insert is being installed in material having maximum strength of less than 80,000 psi and insert Kees cannot be alined with original slots in parent metal, new slots will be broached when Kees are driven in. If insert is installed in material having a maximum strength of 80,000 psi or more and insert Kees cannot be alined with original slots within depth tolerance of 0.010 to 0.030, broach new Kee slots as follows:

(1) Install insert to depth of 0.010 to 0.030 inch below surface of parent metal, and index Kees to parent metal by suitable marking.

(2) Remove insert, and install proper broaching tool to aline cutting edges with index marking on parent metal.

NOTE

Broaching tools are identified by the prefix "B" in the insert or stud part number (example: BKN 524).

(3) Using arbor press or equivalent tool, broach new Kee slots in parent metal.

(4) Reinstall insert to a depth of 0.010 to 0.030 inch below surface of parent metal. Aline insert Kees with broached slots in parent metal.

g. Lift and turn installing tool until slots clear Kees. Drive in Kees using a hammer or an arbor press and installing tool.

1-119. REMOVING HELI-COIL INSERTS.

a. Select extracting tool for insert to be removed, from figure 1-10.

b. Place extracting tool blade into first turn of insert so that one side of blade is 45-90 degrees from end of top coil of insert. (See figure 1-11.)

c. Tap top of tool lightly with hammer so that edge of blade imbeds, gripping insert.

d. Apply heavy hand pressure on tool simultaneously rotating tool counterclockwise until insert is removed.

1-120. INSTALLING HELI-COIL INSERTS.

a. Clean all applicable parts to meet cleanness requirements of engine system to which part is designed to be attached.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

b. Select correct replacement insert from figure 1-12.

c. Obtain Heli-Coil STI tap, inserting tool, and tang breakoff tool indicated for insert in figure 1-10.

d. If necessary, chase threads in tapped hole to remove burs.

e. Clean tapped hole to remove all chips.

f. Gage tapped hole threads with working gage specified in figure 1-10. Use inspection gage if working gage is not available.

g. Adjust stop collar on mandrel to touch tool body when mandrel protrudes through prewinder a distance equal to nominal length of insert plus 1/2 thread.

h. Retract mandrel by turning it counterclockwise. Place insert in chamber, and hold insert with finger to prevent it from falling out; then rotate mandrel clockwise to thread insert onto mandrel.

i. Continue rotating mandrel clockwise until insert protrudes beyond tip of tool approximately one full thread.

Insert Number (Internal Thread)	NAS Number	Installation Data			Removal Data	
		Tap (UNC-2B)				
		Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KN428	NAS1394C4	3/8-16	0.43	T428	9/32	3/16
KNL428	NAS1394C4L	3/8-16	0.43	T428L	9/32	3/16
KNHL820	NAS1395C8L	11/16-11	0.75	TH820L	19/32	3/16
KNHL820LH	NAS1395C8L-LH	11/16-11	0.75	TH820L	19/32	3/16

Figure 1-8. Keenserts Removal and Installation Data

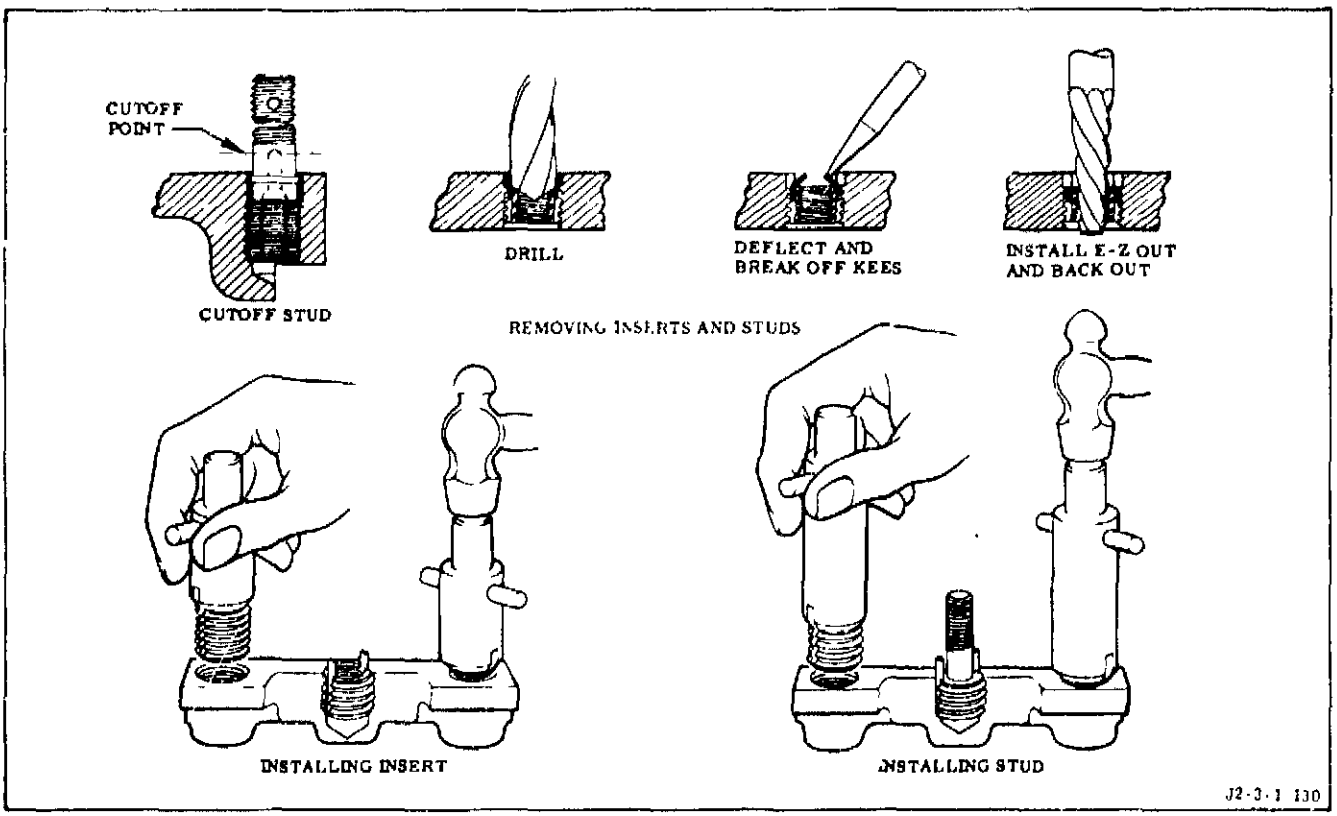


Figure 1-9. Removing and Installing Keenserts

Insert Internal Thread Size	STI Tap Numbers		Threaded Plug Gage Numbers		Insert Inserting Tool Numbers		Insert Tang Breakoff Tool Numbers		Insert Extracting Tool Number
	Plug Style	Bottoming Style	Reference Gage	Working Gage	Plain	Mid-Grip	Plain	Mid-Grip	
#10-32NF-3B	43193-3	27193-3	1694-3	3694-3	7552-3	7552-3	1196-3	3581-3	1227-6
1/4-28UNF-3B	1193-4	5193-4	1694-4	3694-4	7552-4	7552-4	1196-4	3581-4	
5/16-24UNF-3B	1193-5	5193-5	1694-5	3694-5	7552-5	7552-5	1196-5	3581-5	
3/8-24UNF-3B	1193-6	5193-6	1694-6	3694-6	7552-6	7552-6	1196-6	3581-6	
1/2-20UNF-3B	42193-8	44193-8	1694-8	3694-8	7552-8	7552-8	1196-8	3581-8	

Figure 1-10. Heli-Coil Insert Removal and Installation Tools

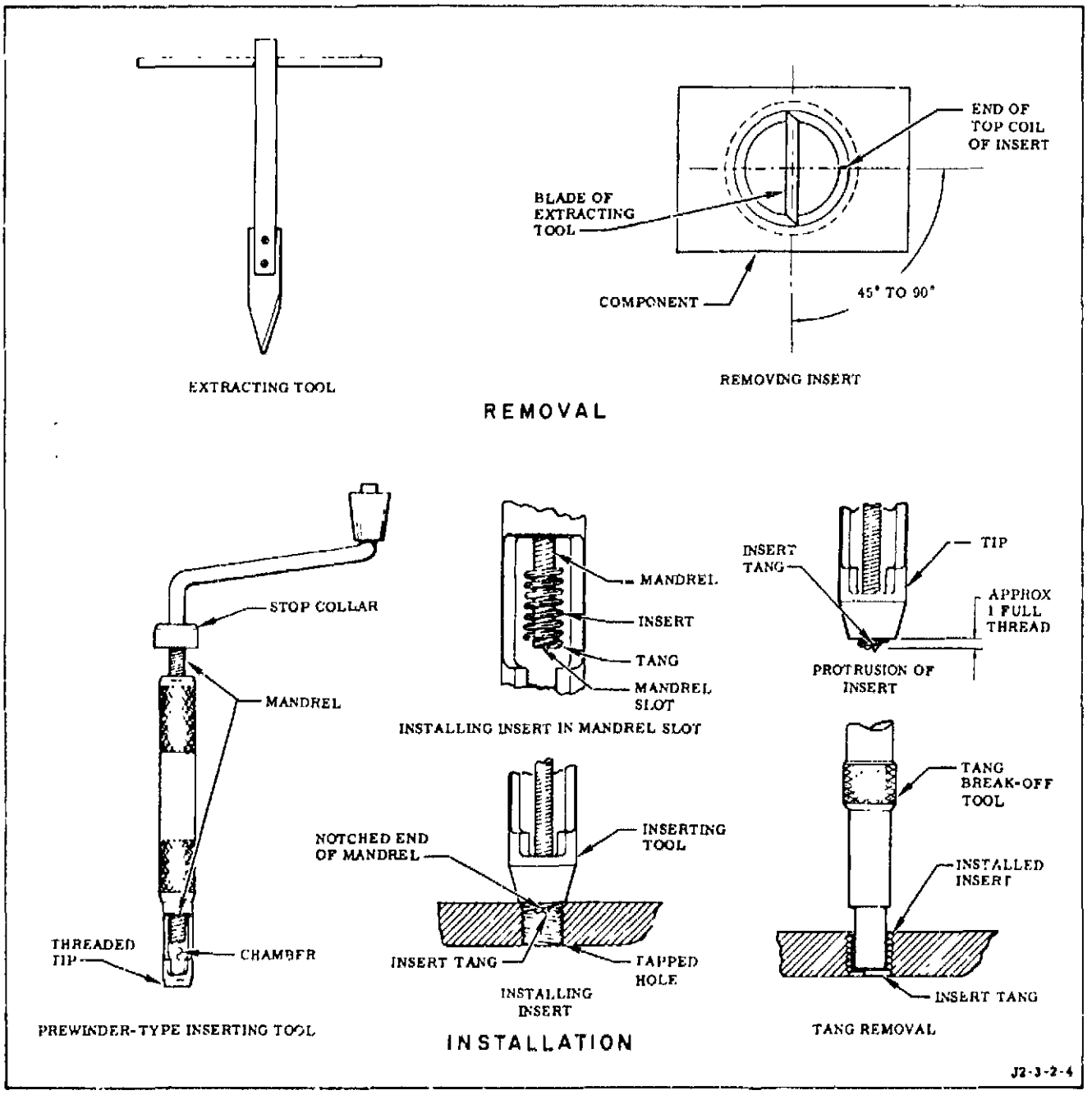


Figure 1-11. Removing and Installing Heli-Coil Inserts

PLAIN NONBOLT-LOCKING-TYPE INSERTS

Internal Thread Size	Length (Inch)	Part Numbers		
		Commercial	New Coordinated Military Standards	Military Standards
10-32	0.285	1191-3CN 0285	21208-F1-15	MS124695
1/4-28	0.375	1191-4CN 0375	21208-F4-15	MS124696
1/4-28	0.500	1191-4CN 0500	21208-F4-20	MS124736
5/16-24	0.469	1191-5CN 0469	21208-F5-15	MS124697
5/16-24	0.625	1191-5CN 0625	21208-F5-20	MS124737
3/8-24	0.562	1191-6CN 0562	21208-F6-15	MS124698
3/8-24	0.750	1191-6CN 0750	21208-F6-20	MS124738
1/2-20	0.750	1191-8CN 0750	21208-F8-15	MS124700

Figure 1-12. Heli-Coil Insert Sizes, Lengths, and Part Numbers

j. Place tool squarely and firmly against tapped hole in component. Rotate mandrel clockwise at a uniform rate until stop collar just contacts tool body and insert is installed 3/4 to 1-1/2 pitches below first full thread.

k. Rotate mandrel counterclockwise until free of insert; then check depth of insert installation.

l. If necessary, readjust stop collar on mandrel and repeat step i until insert is properly installed.

m. If original insert had tang removed, snap off tang of replacement insert by holding automatic breakoff tool against insert tang, and then press preloaded barrel down to release striking punch. If manual breakoff tool is used, removed insert tang by holding breakoff tool against tang and striking protruding rod of tool with hammer. Remove broken insert tang from hole. (See figure 1-11.) For insert sizes over one inch, use long-nose pliers, bending tang up and down to break off tang at notch, and remove tang.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

n. Remove red dye from mid-grip insert before installation in components used for liquid oxygen service. Remove dye with methyl-ethyl-ketone (Federal Specification TT-M-261). Clean insert after dye removal by handwiping with clean trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533).

o. Inspect installed insert by inserting a bolt or screw of applicable size into insert to a depth of 4 complete turns after contacting locking device. Bolt or screw should turn freely by hand until locking device is contacted. Remove bolt or screw.

p. Inspect insert for proper installation depth and for contamination.

CAUTION

Installing bolts in inserts that contain chips or foreign matter can cause galling of the bolt and/or insert resulting in incorrect installation of the bolt.

q. If contamination (chips or foreign matter) is found on inserts, remove with a vacuum cleaner.

1-121. REPLACING ROSAN INSERTS RNS 206SB-8. Rosan inserts RNS 206SB-8 installed in wood can be replaced, if the wood into which they are installed is not damaged, by turning them from the wood in the same manner as a wood screw is removed. To lock these inserts to the wood, they are installed while wet with varnish; it is necessary to fracture this bond to remove the inserts. Before installing replacement insert, coat mating surfaces of insert and wood with varnish (MIL-V-6894). While varnish is still wet, install insert, threading it in until insert bottoms out in existing threads.

1-122. REMOVING ROSAN LOCKRING INSERT RD 3608-L.

a. Using a 15/32-inch-diameter drill, carefully drill approximately 3/32 inch into insert to remove insert-to-lockring serrations. Do not drill further than necessary as damage to parent metal can result.

b. Drive a square screw extractor into insert; then carefully back insert out. As the insert is turned out, it will engage the lockring and extract it. If lockring fails to come out with insert, collapse lockring with a suitable punch or cold chisel. Remove all pieces of lockring.

1-123. INSTALLING ROSAN LOCKRING INSERT RD 3608-L.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

a. Clean all applicable parts to meet the cleanness requirements of engine systems to which part is designed to be attached.

b. If necessary, chase threads in tapped hole with 9/16-12 HC-3 tap.

c. Clean hole to remove all chips.

d. Install insert 0.010 ±0.005 inch below surface. Insert may be installed by hand or using wrench R1108-W (Rosan, Inc).

e. Fit lockring over matching external serrations of insert with undercut side of lockring toward insert. Drive lockring flush or below surface of parent material but above top of insert. Use a flat tool or lockring drive tool R3608-D (Rosan, Inc).

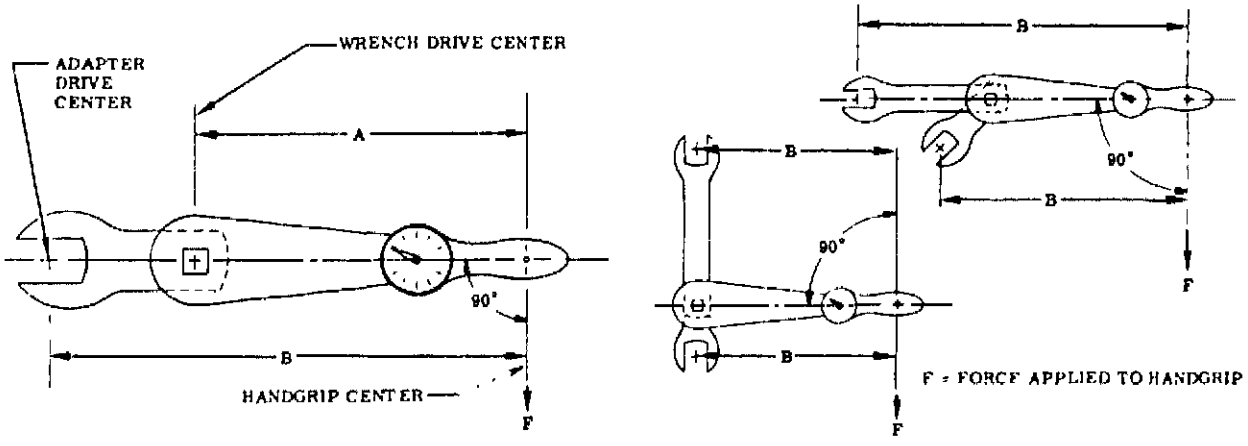
1-124. TORQUING.

1-125. Torque is a twisting force used to apply tension to fasteners. To achieve proper tension and accurate torque readings, the parts must be clean and (when required) correctly lubricated. The torque values called out in procedures in other sections of this manual are design requirements that result in maximum strength and sealing characteristics of the parts.

1-126. USING TORQUE WRENCH.

1-127. Torque wrenches are precision tools and must not be subjected to abuse or misuse. The use of an extension or adapter (figure 1-13) on a torque wrench will result in greater torque applications than indicated on the dial. To obtain correct torque readings, the following steps must be strictly adhered to:

a. All torque wrenches must meet the calibration requirements of Federal Specification GGG-W-00686. Do not use torque wrenches after void date shown on each wrench, and never keep them in tool boxes or line supply cabinets.



When using an extension adapter on a torque wrench, the actual torque value applied may be widely different from the indicated torque value and may be above or below the allowable tolerance unless the proper conversion is used. When the adapter is used at right angles to the torque wrench centerline, dimensions A and B are equal, the conversion factor is 1.00, and the indicated and applied torque values are the same. When the adapter is attached to the torque wrench to effectively lengthen or shorten the moment of applied force, the B dimension changes, and the indicated torque value must be converted to make sure that the proper torque value is applied as follows

1. Measure length of torque wrench from handgrip center to wrench drive center. This is dimension A.
2. With adapter attached to torque wrench in position for use, measure length of torque wrench and adapter. This measurement (dimension B) is taken from handgrip center to adapter drive center.
3. Divide dimension A by dimension B to obtain conversion factor.
4. Multiply required torque value (applied) by conversion factor to obtain torque reading (indicated) that must be used with adapter on wrench. For example:

Dimension A on torque wrench is 12 inches. With adapter installed, dimension B is 17.365 inches. A ÷ B = 12 ÷ 17.365 = 0.691. Assuming the torque wrench with the adapter installed as a straight extension is to be used to tighten a bolt for which the torque value is 570 630 in-lb, 0.691 x 570 = 393.87 and 0.691 x 630 = 435.33. The torque reading (indicated) to be used when this particular adapter is installed on the torque wrench is 394-435 in-lb. If this adapter were installed on the torque wrench in any other position, dimension B would be different and a different torque reading would apply.

J2-3-1-95

Figure 1-13. Computing Torque Values When Using an Extension or Adapter

b. Select correct torque wrench so that wrench will be operated in its upper range (20-100 percent).

NOTE

Torque values in this manual are based on the use of torque wrenches that in the upper 80 percent of their range are accurate to ±4 percent. Torque wrenches calibrated to Federal Specification GGG-W-00686 meet this requirement.

c. Take torque readings only while tightening fastener. Do not overtighten and then loosen to desired torque value.

d. Never jerk torque wrench. Apply force slowly and at 90 degrees to torque wrench handle for an accurate indication of torque being applied.

e. Do not attempt to use torque wrench to tighten fastener to a higher value than maximum value shown on wrench indicator.

f. Install sockets fully on nut or bolt. Maintain a slight in-load on tool to lessen chances of damage to fastener.

1-128. FASTENER CROSS-TORQUE METHOD.

1-129. Figure 1-14 is to be used as a guide for torquing bolted flanges or any bolted joint to apply an evenly distributed axial load to seals and gaskets. The following procedure is to be used when a definite method of torquing is not specified:

a. Cross-torque all bolts, following a numerical sequence similar to applicable pattern in figure 1-14, and continue diagonally until all bolts are torqued to one-third of total torque to be applied.

b. Repeat this procedure, torquing bolts in three increments until total specified torque is obtained.

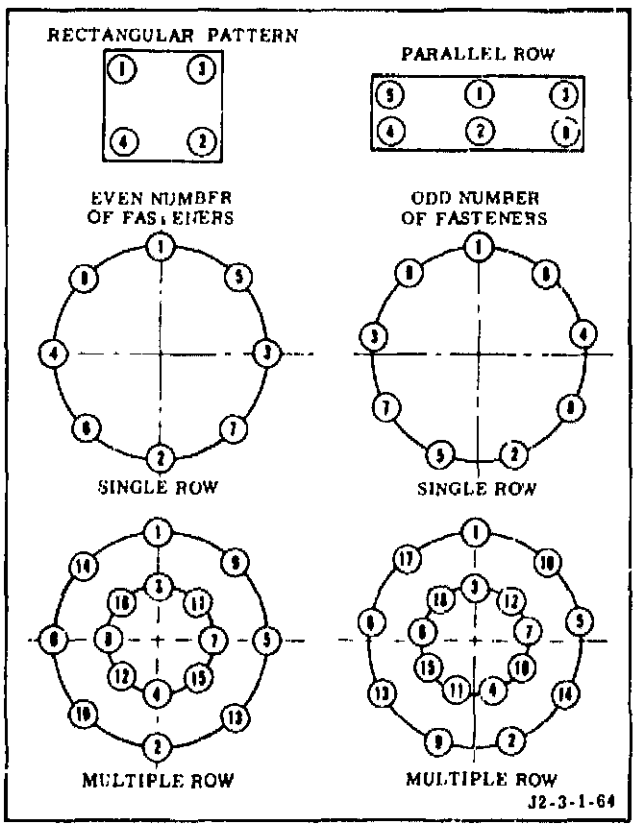


Figure 1-14. Fastener Cross-Torquing Method

1-130. TORQUE VALUE REQUIREMENTS.

1-131. Torque values for threaded fasteners, coupling nuts, and fittings must be as specified in the following paragraphs.

1-132. TORQUE VALUES FOR FASTENERS IN PHENOLIC BLOCK AND LOOP-TYPE CLAMPS. When threaded fasteners are installed in phenolic block and loop-type clamps, nuts must be torqued to 24-30 in-lb (27-33 in-lb if torque is applied to fastener head) unless otherwise specified in the applicable procedures.

1-133. TORQUE VALUES FOR NONLOCKING, FLARED-TUBE COUPLING NUTS. (See figure 1-15.)

	CRES Tubing (MIL-T-6845)	
Tube OD (Inches)	Inch-Pounds	
	Minimum	Maximum
1/8	35	40
3/16	90	140
1/4	135	185
5/16	180	230
3/8	270	345
1/2	450	525
5/8	650	750
3/4	900	1,100
1	1,200	1,400
1-1/4	1,500	1,800
1-1/2	2,000	2,300
1-3/4	2,600	2,900
2	3,200	3,600

Figure 1-15. Torque Values for Nonlocking, Flared-Tube Coupling Nuts

1-134. TORQUE VALUES FOR GASKETED AND NONGASKETED FITTINGS. (See figure 1-16.)

1-135. TORQUE VALUES FOR BOLTS, NUTS, AND SCREWS. To obtain proper torque value for bolts, nuts, and screws, determine part number of item; then see figure 1-17 for tensile strength and figure 1-18 for type. With tensile strength and type established, see figure 1-19 for required torque.

Tube OD (Inches)	Torque Values for Gasketed Aluminum or Steel Fittings[a] (Inch-Pounds)							Torque Values for Jamnuts and Fittings Without Gaskets[b] (Inch-Pounds)			
	Fittings Thread Size	Nut AN924 Union AN815		Plug AN814		Nut AN6289		Aluminum		Steel	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1/8	5/16-24	25	35	10	16	25	35	35	50	--	--
3/16	3/8-24	50	75	30	40	50	75	65	80	70	90
1/4	7/16-20	55	80	40	65	75	100	90	105	110	130
5/16	1/2-20	75	100	60	80	90	120	105	125	140	160
3/8	9/16-18	100	150	80	120	150	200	125	145	225	275
1/2	3/4-16	180	230	150	200	200	250	240	280	400	450
5/8	7/8-14	250	350	200	350	275	400	330	370	550	650
3/4	1.1/16-12	420	600	300	500	450	650	540	660	800	960
1	1.5/16-12	600	840	450	600	650	900	840	960	1,000	1,200
1-1/4	1.5/8-12	720	960	600	720	800	1,000	960	1,200	--	--
1-1/2	1.7/8-12	840	1,080	600	800	900	1,100	1,200	1,440	--	--

(a) For use with O-rings and aluminum, asbestos, leather, Teflon, etc, gaskets or washers.
(b) For combinations of materials (either jamnut, fitting, or boss), use the lowest applicable values shown.

Figure 1-16. Torque Values for Gasketed and Nongasketed Fittings

Bolt or Screw No.	Tensile Strength (psi, min)	Identification	
		Type Head	Markings and Materials[a]
AN3 thru AN20	125,000	Hex	Head marked with one X in center of head with or without single hole drilled in head and/or shank (cadmium plated).
AN21 thru AN36	62,500	Oval	Clevis bolt (cadmium plated); head slotted and marked with one or two Xs, with or without single hole drilled in shank.
AN42B	125,000	Eye bolt	Head marked with basic part number and one X.
AN500	60,000	Fillister	Slotted-head machine screw (cadmium plated), coarse thread, with or without single hole drilled in head.

(a) Material is carbon or alloy steel unless otherwise indicated.

Figure 1-17. Classification of Bolts and Screws (Sheet 1 of 5)

Bolt or Screw No.	Tensile Strength (psi, min)	Identification	
		Type Head	Markings and Materials[(a)]
AN501	60,000	Fillister	Slotted-head machine screw (cadmium plated), fine thread, single hole drilled in head.
AN502 and AN503	125,000	Fillister	Slotted-head machine screw (cadmium plated) marked with one or two Xs on head with single hole drilled in head.
AN505	55,000	82° flush	Machine screw (cadmium plated), coarse thread.
AN507	55,000	100° flush	Machine screw (cadmium plated).
AN507C	70,000	100° flush	CRES machine screw (passivated), size 5 and larger; head marked with 2 depressed "-"s.
AN509	125,000	100° flush	Machine screw; head marked with 1 or 2 Xs (off center).
AN509C	85,000	100° flush	CRES machine screw; head marked with 1 or 2 "-"s.
AN515	55,000	Round	Machine screw (cadmium plated), coarse thread.
AN515C	70,000	Round	CRES machine screw (passivated), coarse thread.
AN515PB	55,000	Round	Brass machine screw (cadmium plated), coarse thread.
AN520	55,000	Round	Machine screw (cadmium plated), fine thread.
AN520C	70,000	Round	CRES machine screw, fine thread.
AN525	125,000	Washer	Screw (cadmium plated).
AN526	55,000	Truss	Machine screw (cadmium plated).
AN101001 thru AN101800	125,000	Hex	Head marked E11 (cadmium plated).
AN103701 thru AN104600	125,000	Hex	Drilled head marked E11 (cadmium plated).
AN104601 thru AN105500	125,000	Hex	CRES, head marked EC3.

(a) Material is carbon or alloy steel unless otherwise indicated.

Figure 1-17. Classification of Bolts and Screws (Sheet 2 of 5)

Bolt or Screw No.	Tensile Strength (psi, min)	Identification	
		Type Head	Markings and Materials[a]
MS9033 thru MS9038	130,000	12-point, external wrenching	CRES, head marked EH19.
MS16638	160,000	Socket head, hex, internal wrenching	Shoulder screw (cadmium or zinc plated).
MS20004 thru MS20024	160,000	Hex, internal wrenching	Head marked with basic MS part number (cadmium plated).
MS21250	180,000	12-point, external wrenching	Head marked with basic MS part number (cadmium plated).
MS35191	55,000	82° flush	Machine screw (cadmium plated), fine thread, cross-recessed drive.
MS35206	60,000	Pan	Same as MS35191 except coarse thread.
MS35233	70,000	Pan	CRES slotted-head machine screw, coarse thread.
MS35234	70,000	Pan	Same as MS35233 except fine thread.
NAS388	55,000	82° oval recessed	Machine screw (chrome plated).
NAS563 thru NAS572	160,000	Hex	Head marked with full part number (cadmium plated).
NAS1003 thru NAS1020	140,000	Hex	CRES, head marked with full part number.
NAS1053	55,000	Shouldered eyebolt	Coarse thread (zinc coated, electro-deposited or hot-dip galvanized).
NAS1100	160,000	Pan	Torq-set machine screw (cadmium plated); no marking required on sizes 00 thru 02; head marked with first dash number only on sizes 04 thru 08; head marked with full part number on sizes 3 and larger.
NAS1100C	140,000	Pan	Same as NAS1100 except material is CRES.
NAS1101	160,000	Flat fillister	Same as NAS1100.
NAS1101C	140,000	Flat fillister	Same as NAS1100C.

(a) Material is carbon or alloy steel unless otherwise indicated.

Figure 1-17. Classification of Bolts and Screws (Sheet 3 of 5)

Bolt or Screw No.	Tensile Strength (psi, min)	Identification	
		Type Head	Markings and Materials[a]
NAS1102	160,000	Flat 100°	Torq-set machine screw (cadmium plated); no marking required on size 02; head marked with first dash number only on sizes 04 thru 08; head marked with full part number on sizes 3 and larger.
NAS1102C	140,000	Flat 100°	Same as NAS1102 except material is CRES.
NAS1103 thru NAS1120	160,000	Hex	Head marked with complete part number and manufacturer's trade mark (cadmium plated).
NAS1190	160,000	Pan	Self-locking full thread screw; no marking required on size 02; head marked with first dash number, manufacturer's trade mark, and a circle of six (min) dots on sizes 04 thru 08; head marked with full part number, manufacturer's trade mark, and a circle of six (min) dots on sizes 3 and larger.
NAS1190C	140,000	Pan	Same as NAS1190 except material is CRES.
NAS1223 thru NAS1226	160,000	Hex	Self-locking bolt; head marked with full part number and where possible with a circle of six (min) dots.
NAS1223C thru NAS1226C	140,000	Hex	Same as NAS1223 thru NAS1226 except material is CRES.
NAS1297	125,000	Hex	Shoulder bolt; head marked with basic and first dash number and manufacturer's identification.
NAS1303 thru NAS1320	160,000	Hex	Shear bolt, head marked with full part number and manufacturer's identification.
NAS1351	55,000	Socket head cap	May be plain or self locking and have drilled or undrilled head; if self locking, on sizes 4 and larger, head will be marked with a minimum of six dots. (May have cadmium plating or black oxide finish.)
NAS1352C	55,000	Socket head cap	Same as NAS1351 except material is CRES and is cadmium plated.
RD111-1009 thru RD111-1012	140,000	Hex	CRES, head marked with full part number and manufacturer's identification.

(a) Material is carbon or alloy steel unless otherwise indicated.

Figure 1-17. Classification of Bolts and Screws (Sheet 4 of 5)

Bolt or Screw No.	Tensile Strength (psi, min)	Identification	
		Type Head	Markings and Materials[a]
RD111-3003	160,000	Internal wrenching	CRES, head marked with basic part number.
RD111-4008 and RD111-4009	200,000	12-point, external wrenching	Head marked with full part number and manufacturer's identification.
5B28	125,000	Hex	Ground handling equipment bolt assembly consisting of bolt (cadmium plated) and washer (CRES) with captive spacer (cadmium plated) and tab (aluminum alclad).

(a) Material is carbon or alloy steel unless otherwise indicated.

Figure 1-17. Classification of Bolts and Screws (Sheet 5 of 5)

Nut Part No.	Tensile Type	Shear Type	Nut Part No.	Tensile Type	Shear Type
AN316		X	NAS509	X	
AN320		X	NAS679	X	
AN335	X		NAS680	X	
AN340	X		NAS686	X	
AN345	X		NAS687	X	
AN363	X		NAS1022	X	
AN121551 thru AN121575	X		NAS1023	X	
			NAS1068		X
MS9356	X		RD114-1001 and RD114-1002	X	
MS9358	X				
MS20341	X		RD114-1004 thru RD114-1007		X
MS20364		X			
MS20500	X		RD114-2003	X	
MS21075		X	RD114-8005	X	
MS35649	X				
MS51957	X				

Figure 1-18. Classification of Nuts

Bolt, Stud, or Screw Size	Shear-Type Fasteners		Tensile-Type Fasteners			
	55,000-89,000 psi	90,000 psi and Greater	55,000-89,000 psi	90,000-124,000 psi	125,000-159,000 psi	160,000 psi and Greater
	in-oz	in-oz	in-oz	in-oz	in-oz	in-oz
0-80	2 to 2.5	5 to 6	3.5 to 4.5	8 to 10	10.5 to 13	14.5 to 18
1-72	4 to 5	9.5 to 12	6.5 to 8.5	15.5 to 20	20 to 25.5	28 to 35.5
2-56	6 to 7.5	14 to 17.5	10 to 12.5	23.5 to 29	30 to 37.5	41.5 to 52
2-64	7 to 8.5	16 to 20.5	11.5 to 14.5	26.5 to 34	34.5 to 43.5	47.5 to 60.5
3-48	9 to 11.5	21.5 to 26.5	15.5 to 19	35.5 to 44.5	46 to 57	63.5 to 79.5
3-56	10.5 to 13.5	24.5 to 31.5	17.5 to 22.5	41 to 52	53 to 67	73.5 to 93
4-40	13 to 16	30 to 37	21.5 to 26.5	50 to 61.5	64 to 79.5	89 to 110
4-48	15 to 19	35.5 to 44.5	25 to 32	59 to 74.5	75.5 to 95.5	105 to 133
5-40	19 to 24	45 to 56.5	32 to 40	75 to 94	96.5 to 120.5	133.5 to 167.5
5-44	21.5 to 27	50 to 63	35.5 to 45	83 to 105.5	106.5 to 135.5	148 to 186
6-32	24 to 29.5	56 to 69	40 to 49.5	93 to 115	120 to 148	166.5 to 205.5
6-40	29 to 36.5	67.5 to 85.5	48 to 61	112.5 to 142.5	144.5 to 183.5	201 to 255

Bolt, Stud, or Screw Size	Shear-Type Fasteners		Tensile-Type Fasteners							
	125,000 psi and Greater		55,000 to 89,000 psi		90,000 to 124,000 psi		125,000 to 159,000 psi		160,000 psi and Greater	
	in-lb	ft-lb	in-lb	ft-lb	in-lb	ft-lb	in-lb	ft-lb	in-lb	ft-lb
8-32	8-11		5-6		11-14		14-18		19-24	
8-36	9-12		5-6		12-15		16-20		22-28	
10-24	12-15		7-8		15-19		20-25		28-35	
10-32	14-18		8-10		19-24		24-30		33-42	
1/4-20	31-39		17-22		40-50		52-65		72-90	
1/4-28	36-47		20-26		47-61		61-75		85-110	
5/16-18	63-80		35-45		80-105		105-135		145-180	
5/16-24	71-90		40-51		90-120		120-155		160-210	
3/8-16	110-140		62-80		145-180		180-230		250-330	
3/8-24	125-160		70-90		160-210		210-280		290-390	
7/16-14	180-230		100-130		230-300		300-380		420-530	
7/16-20	200-260		110-145		250-330		330-430		460-600	35-50
1/2-13	270-350		150-190		350-450		450-580		630-810	50-65
1/2-20	310-410		170-230		400-530		520-680	40-55	720-950	60-80
9/16-12	400-510		220-290		520-670	40-55	670-860	55-70	920-1,190	75-100
9/16-18	450-590		250-330		580-770	45-65	750-990	60-80	1,040-1,380	85-115
5/8-11	550-700		300-390		710-910	60-75	910-1,180	75-95	1,270-1,630	105-135
5/8-18	620-830	50-70	350-460		810-1,070	65-90	1,040-1,380	85-115	1,450-1,920	120-160
3/4-10	960-1,240	80-100	530-690		1,250-1,610	105-135	1,600-2,080	130-170		185-240
3/4-16	1,080-1,430	90-120	600-790	50-65	1,400-1,850	115-155		150-195		200-270
7/8-14		140-190	960-1,270	80-105		185-240		240-310		330-440
1-12		210-290	1,450-1,930	120-160		280-370		360-480		500-670
1-14		210-290	1,460-1,960	120-160		280-380		360-490		500-680
1 1/8-12		310-410		170-230		400-540		520-690		720-960
1 1/4-12		430-580		240-320		560-750		720-970		1,000-1,350

NOTE: When tightening fasteners from the head side, torque to within -10 percent of the high side of the specified torque range

Figure 1-19. Torque Values for Threaded Fasteners

1-136. SAFETYWIRING.

1-137. Safetywiring is the securing together of two or more parts with a wire that is installed in such a manner that the lockwire will be put in tension on at least one side of the part when the part tends to loosen.

1-138. SAFETYWIRING METHODS.

1-139. The lockwire must be as short as possible and attached in the most direct manner. A pigtail of 1/4 to 1/2 inch (3-6 twists) must be made at the end of the wiring and bent back or under in a direction that increases tension and prevents snagging. Any lockwire application that complies with Military Standard MS33540 and meets the requirements of this paragraph is acceptable. Typical safetywiring methods are shown in figure 1-20. The single-wire method may be used for small screws in a closely spaced, closed geometrical pattern, on parts in electrical systems, and in places that are difficult to reach. When safetywiring widely spaced (maximum spacing is 6 inches) multiple groups by the double-twist method, three units is the maximum number in series. When safetywiring closely spaced multiple groups, the number of units that can be safetywired by a 24-inch length of wire is the maximum number in series. Caution must be used during the twisting operation to keep the wire tight without overstressing. Abrasions caused by commercially available wire-twisting pliers are acceptable, but nicks, kinks, and other mutilations caused by improper tooling and wiring techniques are not acceptable. Lockwire must be installed only one time; destroy wire if removed for any reason. Upon installation in the fastener, the lockwire must be anchored to the wire hole provided. In the event that no wire hole is provided, wiring must be to a convenient adjacent part in a manner so as not to interfere with the function of the part. Inconel lockwire MS20995N is used.

1-140. INSTALLING RIGID TUBING.

1-141. During installation of rigid tubing, clamps and line blocks must be positioned to meet the maximum allowable distance between supports, as applicable for tubing (line) size. When specified in installation procedures, coupling nut sleeves and/or fittings must be lubricated before securing rigid tubing.

a. Place tubing (line) in position, loosely supported by clamps and blocks. Tubing (line) must be able to float in clamps and blocks without restraint.

b. Aline both flared ends with sealing surfaces of fittings.

c. Tighten coupling nuts fingertight to seat flares.

d. Hold fittings with wrench and torque coupling nuts.

e. Tighten line clamps and blocks after tube (line) is secured at both ends.

f. Make sure maximum spacing between line supports is as follows:

Diameter of Tubing (Lines) (Inch)	Maximum Spacing (Inches)
1/4 to 3/8	18
1/2 to 3/4	25-1/2
1 or over	30

g. When either of 2 parts is designed for dynamic motion (independent of vibration), make sure 1/2-inch clearance is maintained between tubing (line) and adjacent part.

h. Make sure tubing (lines) under static conditions has a minimum clearance of 1/8 inch between tubing (line) and any adjacent part except as specified in applicable installation procedure.

1-142. INSTALLING FLEXIBLE HOSE.

1-143. During installation, flexible hoses must be supported and prevented from flexing beyond the minimum bend radii used in final installation. When specified in installation procedures, end fittings must be lubricated before securing flexible hoses. Flexible hoses must not be twisted (torsionally deflected) during installation.

a. Position hose between end fittings. Hose must not be stretched between fittings; allow 5 percent of hose length for slack.

b. Route and support hose to provide a minimum clearance of 1/2 inch between hose and adjacent parts.

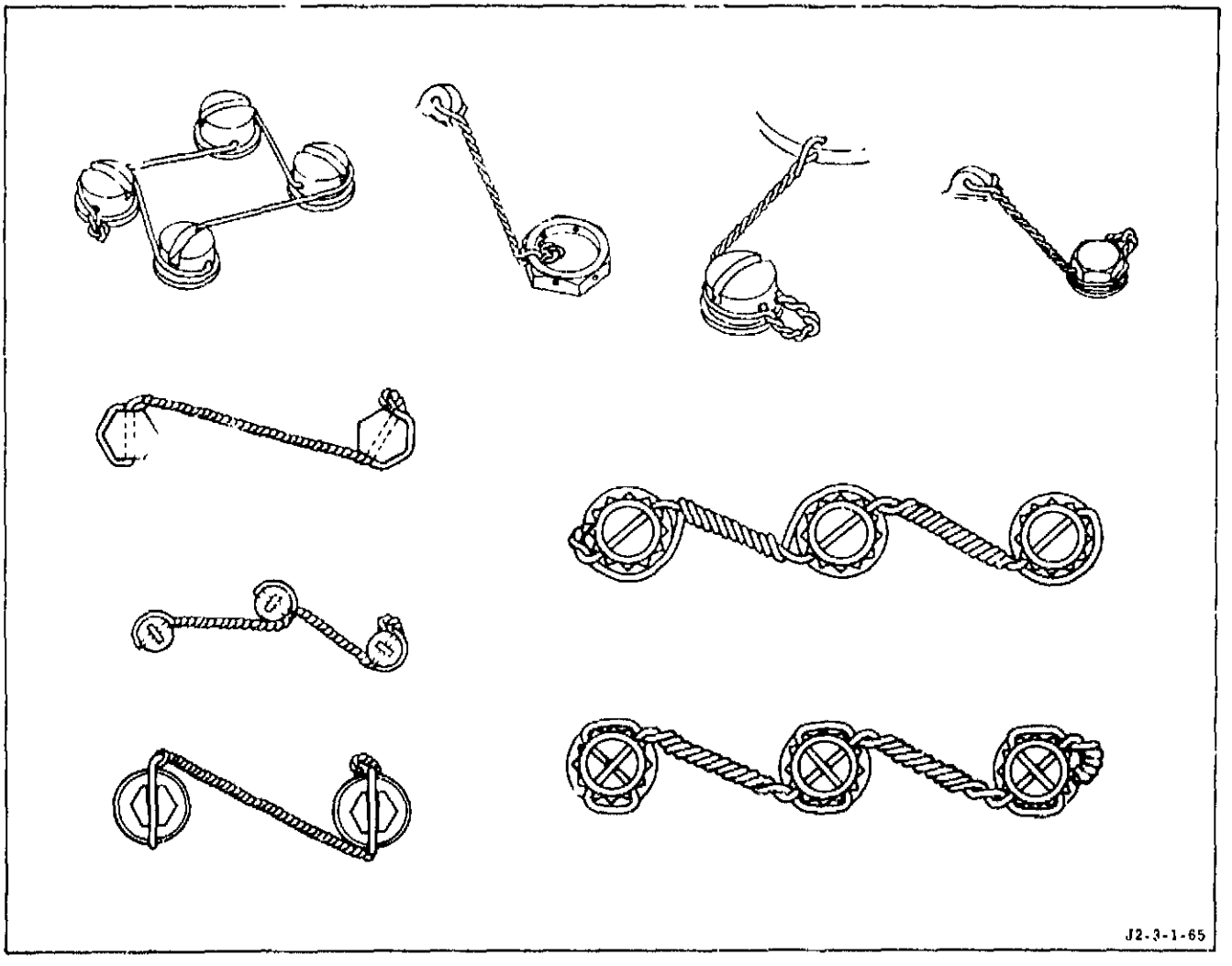


Figure 1-20. Safetywiring Methods

c. Avoid sharp bends, distortion, or strain at hose ends or supports.

d. Position clamps and supports to provide hose clearance, routing, and loose support during installation.

e. Place hose in clamps and aline; hand-tighten coupling nut at one end. Hold fitting with wrench and torque hose coupling nut.

f. Make sure hose is not twisted, is free from binds and restraints, and floats in clamps and supports.

NOTE

Evidence of twisting can be ascertained by observing the stripe on the hose.

g. Hand-tighten coupling nut on opposite end of hose. Hold fitting with a wrench and torque coupling nut.

h. Check hose for evidence of twists or sharp bends. Tighten clamps and supports.

1-144. INSTALLING ELECTRICAL HARNESS OR CABLE.

1-145. Electrical harnesses or cables must be supported and protected during installation, and bend radius and clearances must be maintained. The following requirements are applicable during installation:

WARNING

Connecting electrical connectors without turning off electrical power can result in injury to personnel and damage to equipment.

a. Make sure that electrical power source is turned off.

b. Position harness on equipment, routing to respective connect points.

c. Whenever possible, connect electrical connectors to their respective connect points before installing support clamps, to prevent possible preloading of connectors.

d. Install support clamps, making sure that harness bend radius is not less than outside diameter of harness and distance between support clamps does not exceed 18 inches.

e. Position support clamps to maintain the following acceptance clearances:

(1) A 1/2-inch clearance must be maintained between harness and adjacent structure, if possible. Harness must not touch, chafe, or abrade against adjacent surface, except that two or more harnesses routed side by side may touch one another. See figure 1-21 for support and separation clamping.

(2) Harnesses routed adjacent to tubing (lines) that carry flammable fluids or gases must be clamped in place to maintain a minimum clearance of 1/2 inch.

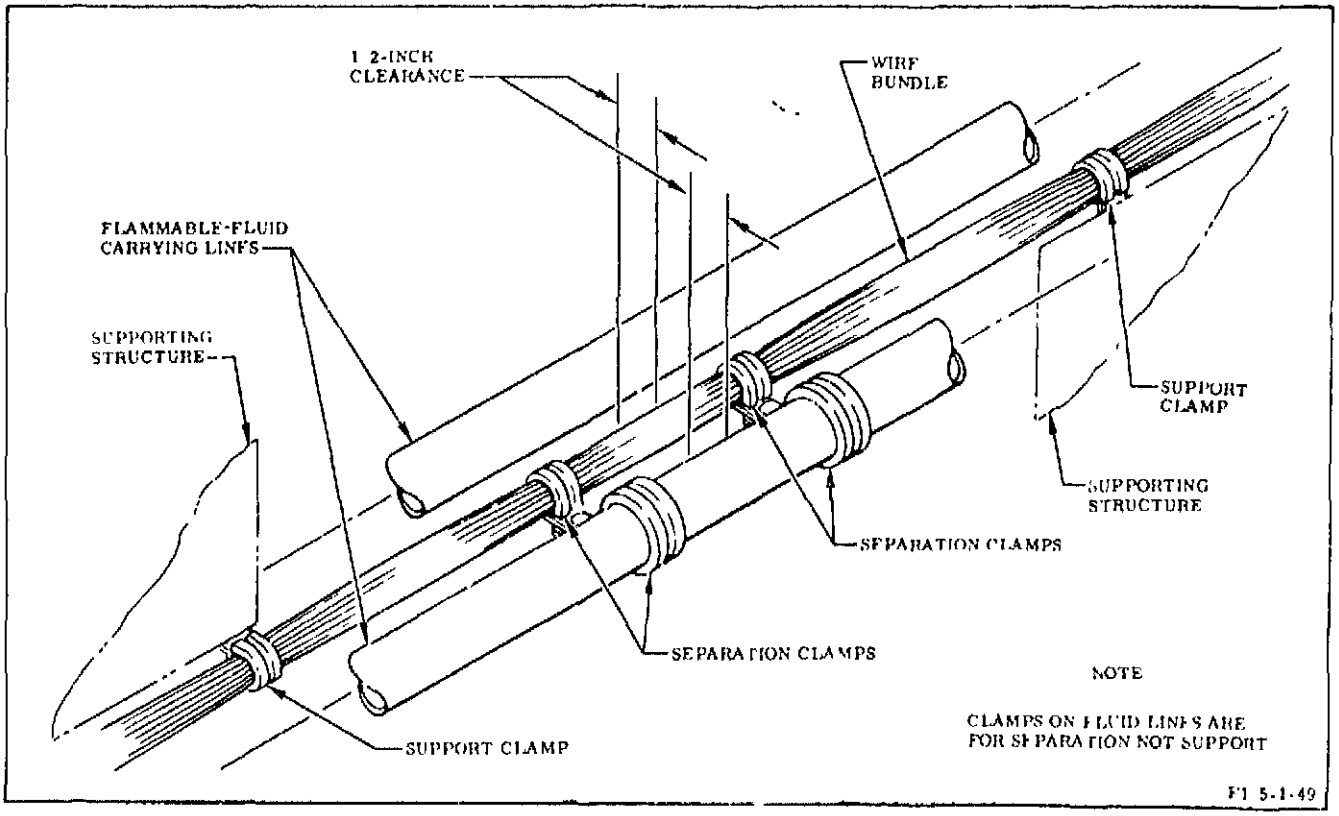


Figure 1-21. Electrical Harness or Cable Support and Separation Clamping

f. Install bonding and ground returns so that vibration, movement, and expansion or contraction of abraded objects will not break or loosen connectors.

NOTE

The bonding contact area must be free of dirt, grease, paint, and protective finish. Bonding must be a bare metal-to-metal contact.

g. After installation of bonding and ground returns, protect bonding contact area with blue-tinted lacquer ST0125RB0003 (Rocketdyne).

1-146. SHIPPING AND STORING.

1-147. Shipping and storing of ground support equipment components or parts must be accomplished in accordance with requirements specified in the Rocketdyne Automated Packaging System (RAPS). Components or parts must meet the following requirements before packaging for storage or shipping:

a. All protective closures, caps, and plugs must be properly installed on the component or part, and the level of cleanness and service must be indicated on each closure.

b. The bags in which components or parts are packaged must be sealed; the level of cleanness and service must be indicated on the exterior of the package.

c. The component or part must be packaged using the Rocketdyne Automated Packaging System, or an equivalent procedure.

1-148. ROCKETDYNE AUTOMATED PACKAGING SYSTEM.

1-149. The Rocketdyne Automated Packaging System (RAPS) is an IBM tabulation report listing the part number, preservation method, cleaning requirements, packaging and packing requirements, and supplemental data. Code characters (alphabetical or numerical) are assigned to the shipping and storage requirements (tabulated on the cover page of RAPS) to minimize printout of the RAPS report. Column headings and code characters are as follows:

a. Federal stock numbers, where applicable, are listed in the first column. Part numbers are listed in the second column in alphanumerical sequence.

b. The preservation method (MIL-P-116) is designated by a two-character code in the PRES/METH column:

PRES/METH	Method
10	III
11	I
2E	IC1
3G	IA-8
3H	IA-16
3P	IA-15
3Q	IA-14
4C	IIC
4H	IIa
4Q	IIb
4V	IId
BJ	II

c. The quantity-per-unit pack is designated by a one-character code in the QUP column:

QUP	Quantity
1	1
5	5
A	10
H	25

d. Clean and dry is designated by a one-character code in the CLN/DRY column:

CLN/DRY	Clean and Dry Process
0	Any applicable process for general cleanness
1	Any applicable process for general cleanness
3(a)	Petroleum solvent, 2-step, Method C-3, RA0116-027 (Rocketdyne)
5(a)	Petroleum solvent fingerprint remover, Method C-5, RA0116-027 (Rocketdyne)
Z(a)	Special requirement. (See supplemental data.)

(a) Not essential for shipments from field sites.

e. The preservation material is designated by a two-character code in the PRES/MATL column:

PRES/MATL	Preservation Material
00	No requirement
11(b)	Grease, Type 11, RA0116-027 (Rocketdyne)
17(b)	Oil, Type 17, RA0116-027 (Rocketdyne)
89(b)	Normal operating lubricant
ZZ	Special requirements. (See supplemental data.)

f. Wrapping material is designated by a two-character code shown in the WRAP column:

WRAP	Wrapping Material
OO	No requirement
AA	Polyethylene foam, 1/8 inch thick
DA	Tissue paper (Federal Specification UU-P-553)
EA	Neutral paper (MIL-P-17667)
FA	Laminated and creped paper (MIL-P-130)
GB	Grade A wrap (MIL-B-121, Grade A)
JA	Polyethylene film (Federal Specification L-P-378)
ZZ	Special requirement. (See supplemental data.)

g. Cushion or dunnage is a two-character code shown in the CUSH/DUNN column:

CUSH/DUNN	Cushion or Dunnage
OO	No requirement
AA	Polyethylene foam
FL	Hair latex (MB0295-003 and MIL-C-7769)
GA	Polyurethane foam (MIL-P-26514, Type ., Class 2)
JA	Fiberboard stiffener, one side (Federal Specification PPP-F-320)
JB	Fiberboard stiffener, 2 sides (Federal Specification PPP-F-320)
JC	Fiberboard pads, cells, sleeves, etc (Federal Specification PPP-F-320)
LK	Wood blocking and bracing, and/or steel strapping
ZZ	Special requirement

h. Cushion thickness is a one-character code shown in the THK column:

THK	Cushion Thickness
O	Not applicable
A	1/4 inch
B	1/2 inch
D	1 inch
F	1-1/2 inches
H	2 inches
M	3 inches
R	4 inches
X	Thickness (dunnage) as required to restrict movement within container
Z	Special requirement. (See supplemental data.)

i. Supplemental data is shown to the right of essential data and on successive lines. Supplemental data includes specific unit container requirements, reinspection data, and other special data.

j. Reinspection data will be characterized by REINSP at its beginning. The type of reinspection required and the reinspection interval will be designated.

(b) Desiccant and bag LK390-0002 or LK390-00064 may substitute for preservatives for shipments from field sites.

SECTION II

THRUST CHAMBER THROAT PLUG KIT G3120

WARNING

THRUST CHAMBER THROAT PLUG KIT G3120 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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2-3	Configuration Changes--Manual Effectivity	2-1
2-5	MAINTENANCE REQUIREMENTS	2-1
2-7	Repairing Throat Plug Pads	2-1

Underlined titles denote primary paragraphs.

2-1. DESCRIPTION AND LEADING PARTICULARS. (See figure 2-1.)

2-2. The thrust chamber throat plug kit seals the thrust chamber throat to prevent loss of pressure during propellant system leak tests. The kit consists of a throat plug, an injector shield, and a container for transport and storage. The plug, comprised of two symmetrical pieces which, when mated, form a truncated cone, is made of laminated wood. Rubber, bonded to the plug, effects the seal. The plug utilizes a dense rubber with a molded surface that matches the convolutions of the thrust chamber throat. A pressurization tap and a burst diaphragm provide means for safely pressurizing the engine through the throat plug. A mechanical device operated by a handscrew aids in separating the halves after a pressure test. The throat plug is installed on the combustion side of the thrust chamber throat. Pressurizing gas entering the combustion area forces the sealing surfaces of the throat plug against the thrust chamber throat and seals the system. See figure 2-2 for leading particulars. Instructions for the use of the plug kit are in R-3825-1B and R-3825-3.

2-3. CONFIGURATION CHANGES-- MANUAL EFFECTIVITY.

2-4. Modifications incorporated in this manual that change the configurations of the thrust chamber throat plug kits are listed in figure 2-3.

2-5. MAINTENANCE REQUIREMENTS.

2-6. Maintenance tasks required on thrust chamber throat plug kit are listed in figure 2-4. Information presented outlines the tasks to be performed, when the tasks must be performed, and refers to data necessary to accomplish these tasks.

2-7. REPAIRING THROAT PLUG PADS.

2-8. Repair loose throat plug pads as follows: (The throat plug, pad, and all chemicals must be stabilized at a temperature of 65° to 110° F.)

a. Carefully establish extent of areas requiring repair by lightly pulling on pad with fingers. If total debonded area on 1/2 of plug exceeds approximately 15 sq in., reject entire plug.

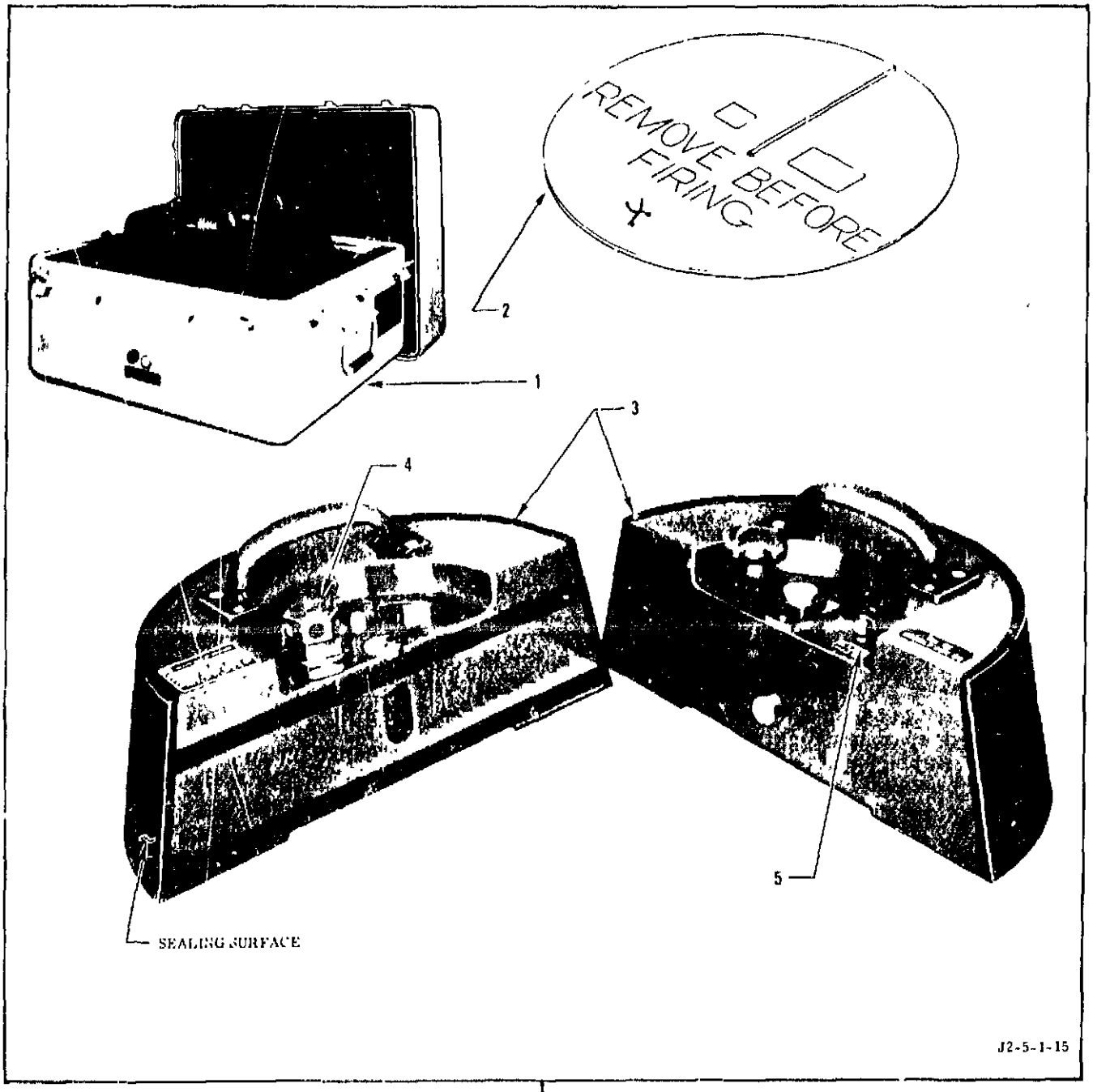
b. If total debonded area on 1/2 of the plug is less than 15 sq in., remove old adhesive from debonded areas of plug by scraping with a knife or sanding with coarse-grit (No. 1) sandpaper. Clean with brush or gentle air blast.

WARNING

The following specifies Versamid 125 and Epon 828, which may irritate skin. Protective clothing must be worn when handling material. In case of contact, wash skin with soap and water.

c. Prepare sufficient adhesive by mixing chemicals by weight in ratio of 3 parts of Versamid 125 (General Mills) to 2 parts of Epon 828 (Shell Chemical Co). Stir until completely blended. Mixture will be usable for approximately one hour.

d. Apply a thin, even coat of adhesive to prepared surfaces of plug and pad.



Index Number	Nomenclature	Quantity (One each except as noted)	Index Number	Nomenclature	Quantity (One each except as noted)
1	Container		4	Burst diaphragm	
2	Shield assembly	3	5	Pressurization tap	
3	Plug assembly				

Figure 2-1. Thrust Chamber Throat Plug Kit

Diameter	15.2 to 18.1 inches
Weight	35 pounds
Bearing surface	320 sq in.
Operating pressure	30 psig
Burst diaphragm burst pressure	50 psig

Figure 2-2. Leading Particulars

Approved ECP No.	MD No.	Incorporated In Manual Dated
J2-153	1	30 July 1964
J2-334	2	21 June 1965
J2-530	3	16 December 1966

Figure 2-3. Configuration Changes--Manual Effectivity

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect kit for completeness.	X				See figure 2-1.
Leak-test burst diaphragm.				X	CAUTION Leak-test compound must not be allowed to contact the rupture disk since damage to the material can result. Test at next use any time packing is disturbed. Use leak-test compound (MSFC-SPEC-384). Leakage is not allowable.
Clean test kit.		X		X	WARNING Freon is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation. CAUTION Torque loads applied to the diffuser can damage the burst diaphragm. Prior to storing in container, clean injector shields and throat plug, except burst diaphragm, by wiping with a clean, lint-free cloth saturated with Freon TF (DuPont).

Figure 2-4. Maintenance Requirements (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Reference Remarks
					Clean burst diaphragm as outlined in section I. Do not disassemble burst diaphragm for cleaning. When removing or installing burst diaphragm, apply torque load to burst diaphragm body, not diffuser. Lubricate packing (Method J, section I) and threads (Method A, section I) with sealing and antiseize compound RB0140-005 (Rocketdyne). Torque to 150 ±15 in-lb.
Inspect throat plug:					
Pad and sealing surfaces for evidence of deterioration.	X	X			Reject throat plug.
Pad for adhesion to throat plug.		X			Repair pad. Refer to paragraph 2-9.
Handscrew for galled or worn threads and ease of operation.	X	X			Replace handscrew.
Inspect container:					
Vent valve for ease of operation.		X			Replace container.
Humidity indicator for security.		X			Replace container.
Interior protective pad for damage and cleanness.		X			Replace container.
Inspect shield for cracks and nicks.	X	X			Replace shield.
Replace pads.				X	When removal of throat plug from thrust chamber becomes difficult.

Figure 2-4. Maintenance Requirements (Sheet 2 of 2)

e. Secure pad to plug with masking tape (Federal Specification UU-T-106), or equivalent.

f. Wipe off excess adhesive, and allow plug to cure for 24 hours at a temperature of 65° to 110° F.

g. Remove masking tape.

Pages 2-5 through 2-8 deleted.

SECTION III

THRUST CHAMBER PROTECTIVE PAD 9016705

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3-3	MAINTENANCE	3-1

Underlined titles denote primary paragraphs.

3-1. DESCRIPTION AND LEADING PARTICULARS.

3-2. The thrust chamber protective pad (figure 3-1) is used when personnel are required to enter the thrust chamber with the engine in a horizontal position. The pad, triangular in shape and approximately 9 feet in length, is 17 and 96 inches at the narrowest and widest points. It consists of a cushioning material covered with vinyl-coated nylon.

3-3. MAINTENANCE.

3-4. Maintenance tasks required on the thrust chamber protective pad are listed in figure 3-2. Information presented outlines the tasks to be performed, when the tasks shall be performed, and reference to data necessary to accomplish these tasks.

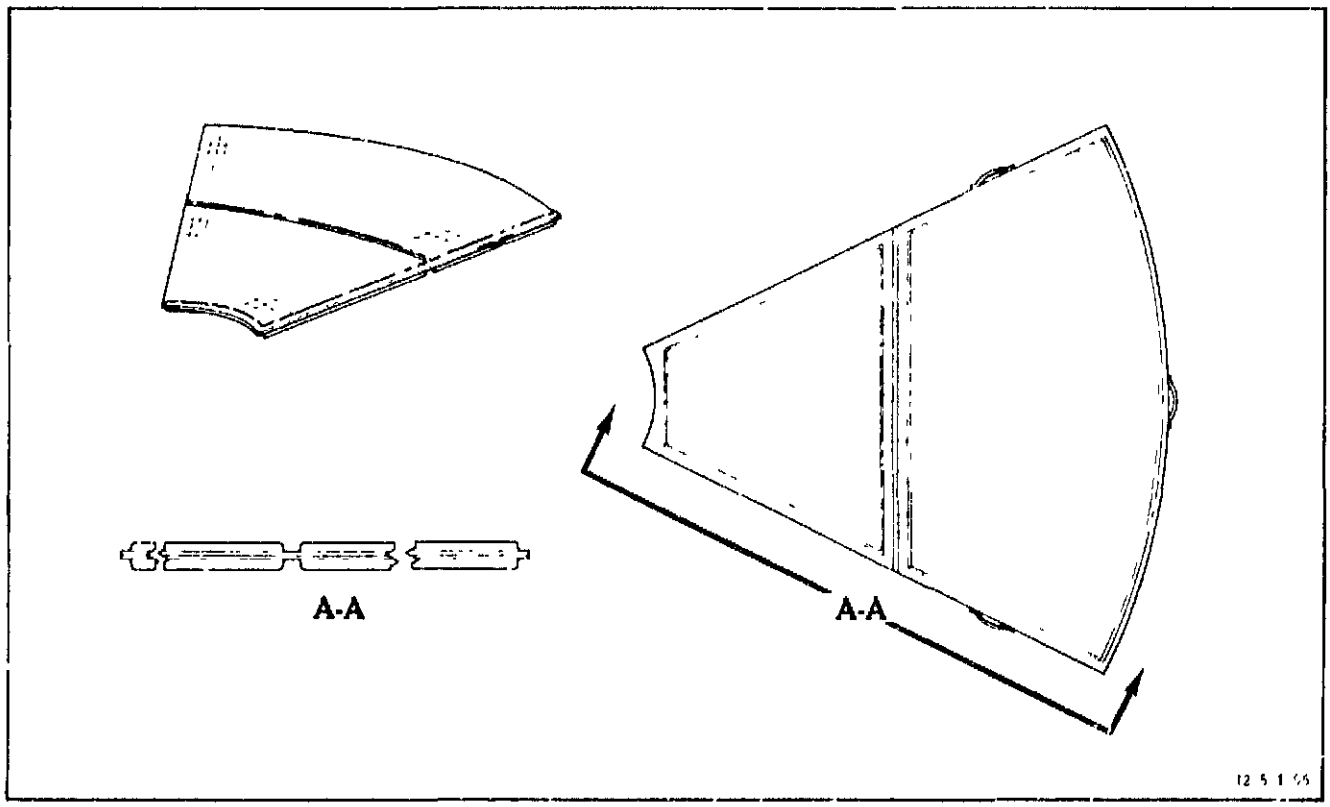

Figure 3-1. Thrust Chamber Protective Pad

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Clean pad.		X			Remove normal soil by wiping with solution specified for immersion cleaning (section I). Remove oil or grease by wiping with a soft, clean cloth moistened with drycleaning solvent (Federal Specification P-D-680, Type I or II, or equivalent), and wipe dry.
Inspect pad for tears.	X	X			Replace pad.

Figure 3-2. Maintenance Requirements for Thrust Chamber Protective Pad

SECTION IV

ELECTRICAL CHECKOUT CONSOLE G1037

WARNING

ELECTRICAL CHECKOUT CONSOLE G1037 AND DATA RECORDER CONSOLE G3121 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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4-1. DESCRIPTION AND LEADING PARTICULARS FOR ELECTRICAL CHECK-OUT CONSOLE.

4-2. The Electrical Checkout Console (figure 4-1) function-tests the engine electrical system. The console is an electrical unit which performs component tests, a sequence test, and a simulated firing test. It consists of 6 electrical panels: the engine test monitor, engine control, ground relay, simulator, spark monitor, and the propellant utilization valve position controller. Four panels are mounted on the face of the cabinet; the other two are mounted in a sloping rack attached to the face. Each panel face measures approximately 10-1/2 inches in height and 19 inches in width. The cabinet mounts on a rectangular steel base which extends in front of the console to increase stability. A drawer at the base of the console cabinet stores electrical cables. Cables which exceed the storage capacity of the drawer are stored in Flight Instrumentation Checkout Console G1035. Two doors on the back of the console provide access to the back of 4 of the electrical panels, to the terminal boards, and to the wiring assemblies. The interface panel between the 2 access doors provides receptacles for connecting external cables necessary to check the engine system and to self-check the console circuitry. The external cables for 28-vdc and 115-vac electrical power and for console earth ground are customer-furnished. A 1/4-inch stud is provided on the lower left rear of the console for electrical grounding. See figure 4-2 for leading particulars of the console. Instructions for the use of the electrical checkout console are in R-3825-1B.

4-3. ENGINE TEST MONITOR PANEL.

4-4. Engine Test Monitor Panel 9024525-11 (figure 4-3) is an electrical unit which selects either of 2 test modes, a component test or a sequence test. The panel monitors the operation of certain engine functions by monitoring 0-5 vdc signals from the engine control and ignition buses, and output voltages from the multiplex units. The components test mode allows for individual operation of specified engine components, and the sequence test mode allows certain engine circuits to be bypassed, permitting a sequence test of engine electrical system. The engine test monitor panel requires 28 ±2 vdc and contains indicator lights, switches, test jacks, 3 electrical receptacles, a ground connector, and electrical circuitry. Circuitry is provided to check out calips pressure switches and temperature transducers, and to verify continuity of the propellant utilization valve jumpers. Panel 9024525-21 incorporates an additional diode and changes the circuitry to provide protection for the existing diode in the engine electrical control assembly. Panel 9024525-31 incorporates revisions to the fuel injection temperature OK, the temperature OK bypass, and the temperature detector bypass circuits.

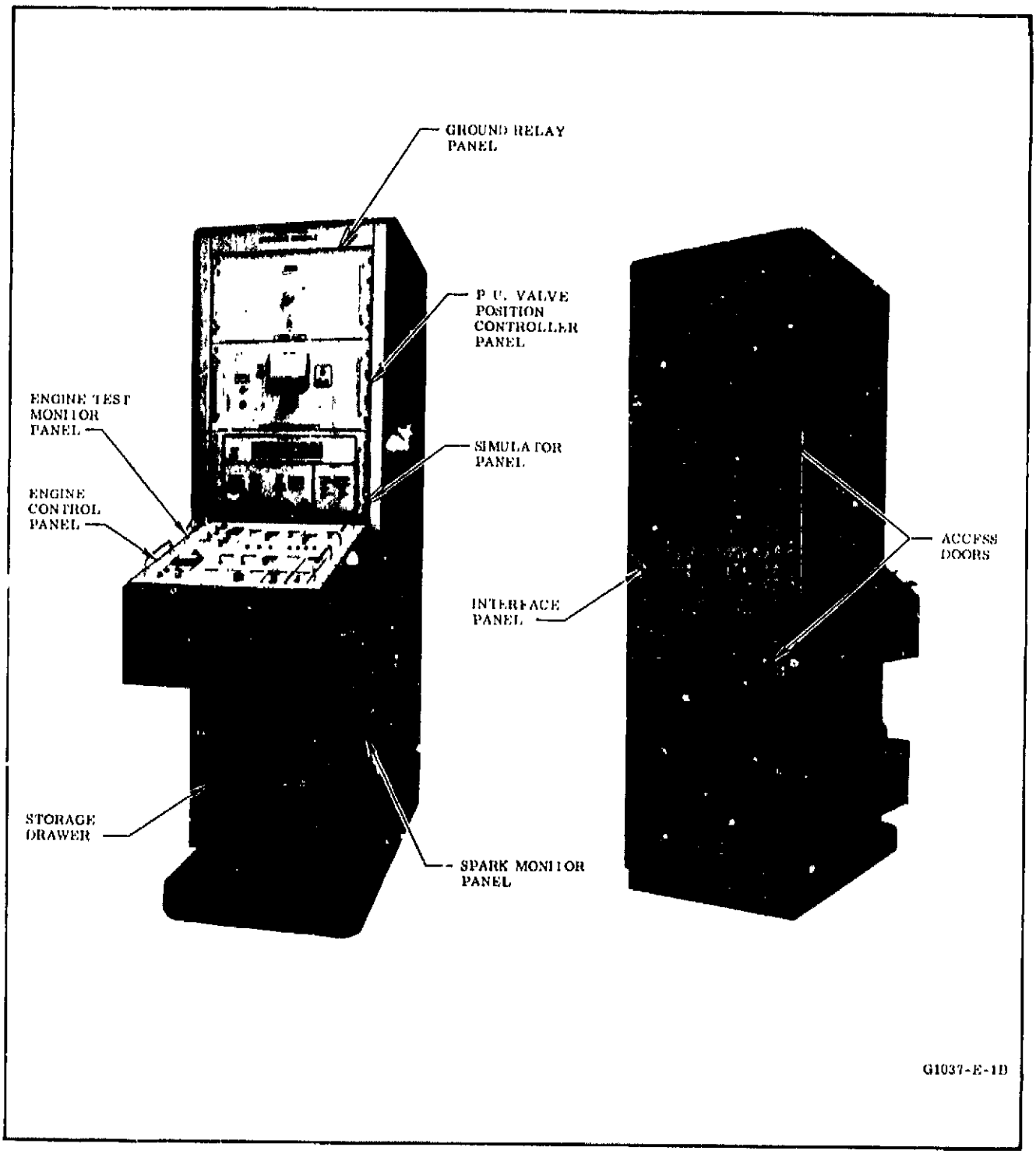


Figure 4-1. Electrical Checkout Console

Height	78-1/2 inches
Width	22-5/32 inches
Depth	25-5/8 inches
Power	
Direct Current	28 ±2 volts, 600 volt-amperes to interface receptacle J5. Pins A and C are positive and pins B and D are negative. Negative return must be connected to earth ground at power supply.
Alternating Current	115 ±5 volts, 400 ±4 cps having less than 3 percent distortion, 120 volt-amperes to interface receptacle J4. Phase to pin A and neutral to pin B. Pin D is a shield tie. Neutral return must be connected to earth ground at power supply. Positive going cycle to pin A, and negative going cycle to pin B. Pin D is a shield tie.
Earth Ground	8 AWG (or equivalent) wire from earth ground to grounding stud E1 at lower left rear of console.
Current Capacity of Main Circuit Breaker	50 amperes

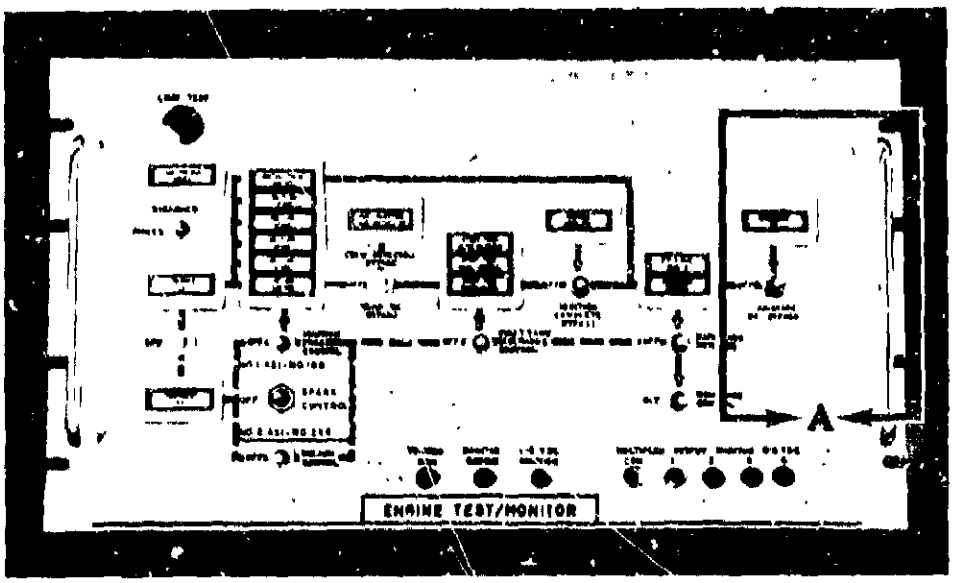
Figure 4-2. Leading Particulars for Electrical Checkout Console

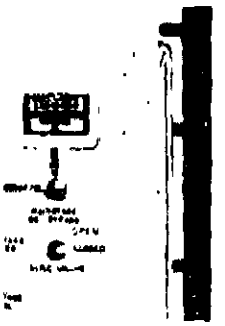
4-5. ENGINE CONTROL PANEL.

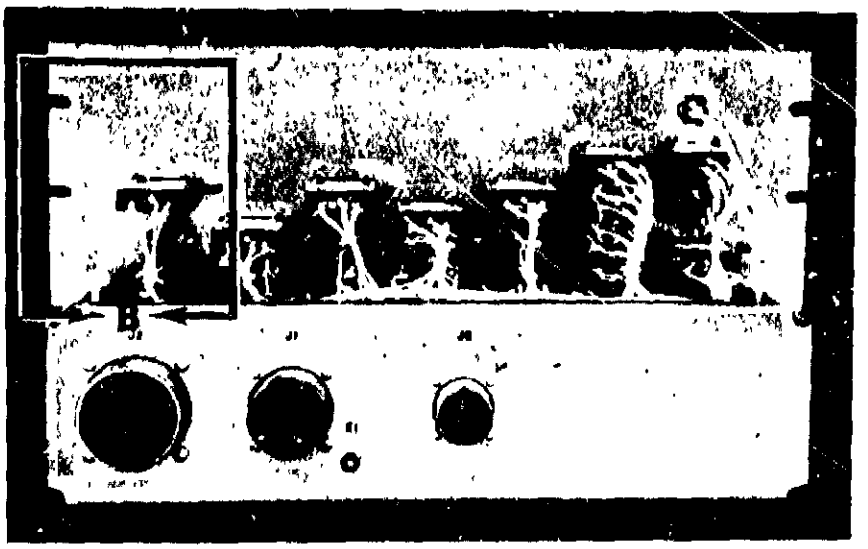
4-6. Engine Control Panel 9018568-11 (figure 4-4) is an electrical unit which controls and monitors engine ground power and engine buses. It also controls and monitors certain facility and engine system functions during checkout and simulated firing test, and incorporates a switch that permits selection of power to the temperature detector bypass circuit. The engine control panel requires 28 ±2 vdc at 5 amperes and contains indicator lights, switches, circuit breakers, a 0-50 vdc voltmeter, 3 electrical receptacles, a ground connector, and electrical circuitry. On panel 9024476-11, the indicator light nomenclature is changed to provide an emergency start tank vent indication.

4-7. GROUND RELAY PANEL.

4-8. Ground Relay Panel 9025101-51 (figure 4-5) is an electrical unit which distributes direct-current voltage to ground power, engine control, and engine ignition buses. It receives control signals from other panels, transmits interlocked control signals to the engine, and selects test circuitry for engine checkout or armed firing. Engine electrical signals are received, isolated, transmitted, or multiplexed for recording and monitoring purposes. The panel circuitry eliminates potential sources of electrical damage to the engine electrical control assembly and incorporates an armed temperature detect bypass signal. The ground relay panel requires 28 vdc at a maximum of 50 amperes and contains a circuit breaker, a key switch, relays, 9 electrical receptacles, a ground connector, and electrical and electronic circuitry. Panel 9024478-11 incorporates circuitry changes that provide for an emergency start tank vent control.







1 ON CONSOLES INCORPORATING MD16 CHANGE

J2-5-1-16A

Figure 4-3. Engine Test Monitor Panel

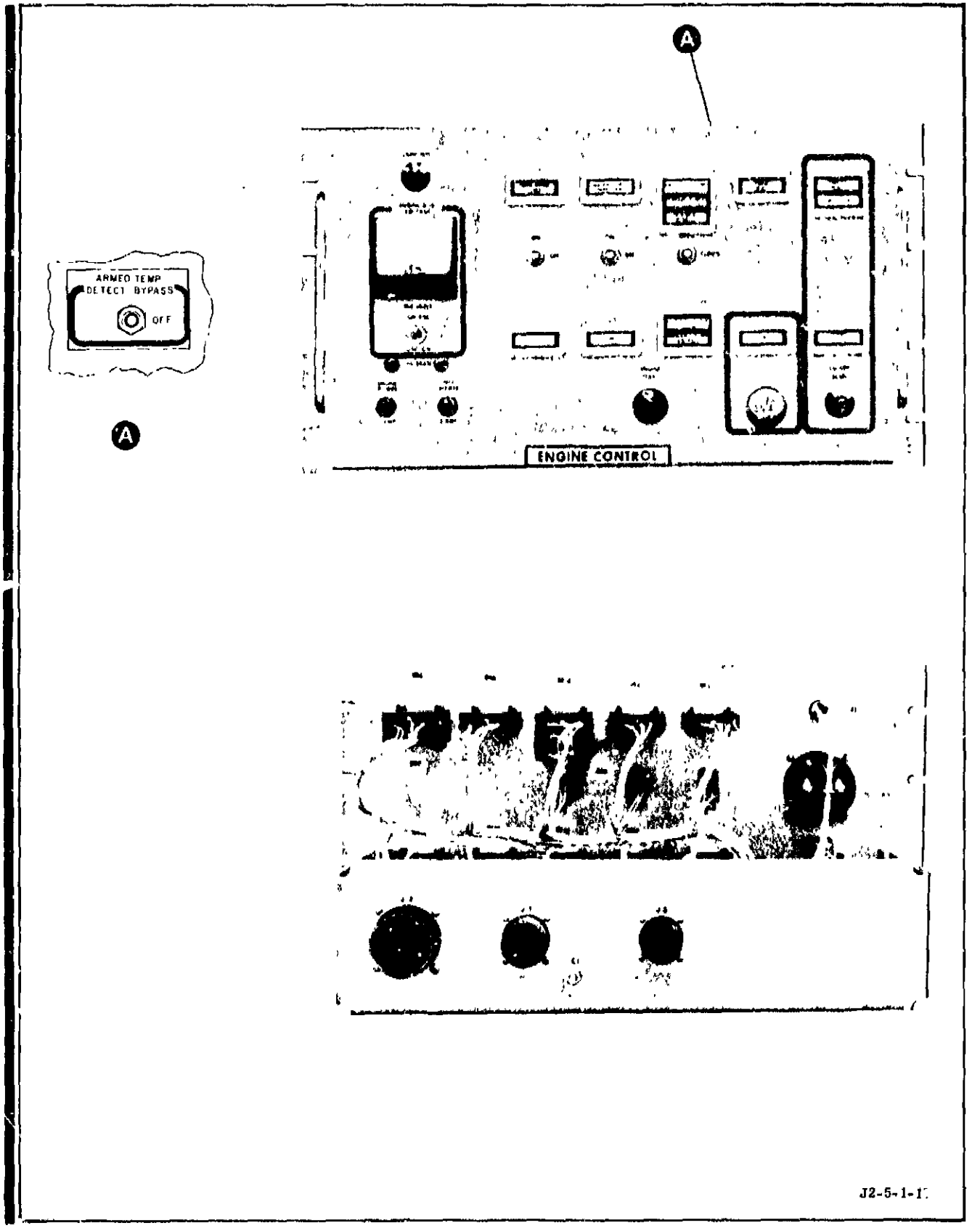


Figure 4-4. Engine Control Panel

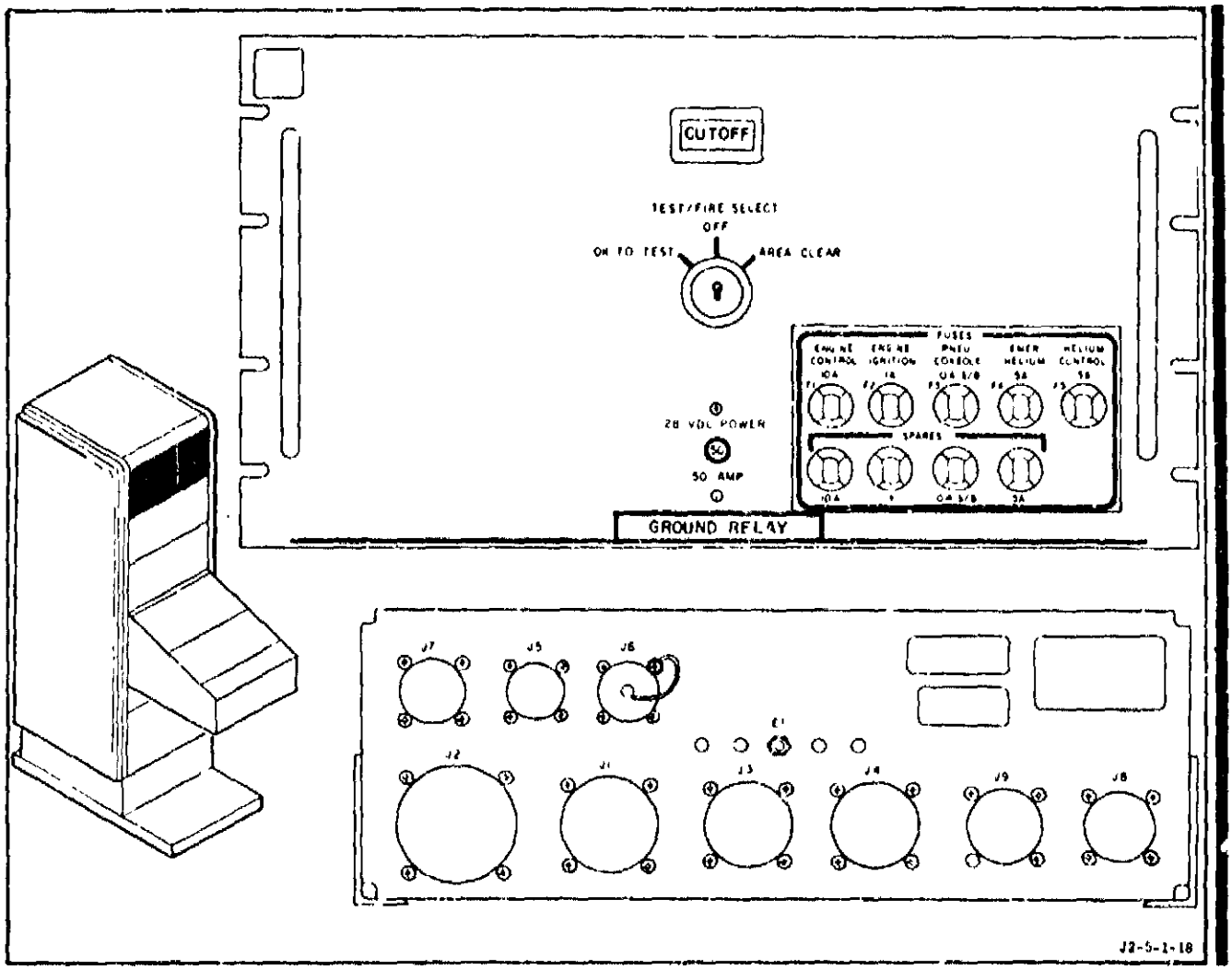


Figure 4-5. Ground Relay Panel

4-9. SIMULATOR PANEL.

4-10. Simulator Panel 9025099-51 (figure 4-6) is an electrical unit which simulates engine facility and engine controller electrical functions for self-checkout of the console. It simulates engine components to check out the engine controller as a component, checks out the engine controller and engine harness as a unit, or checks out and calibrates the spark exciter monitor circuit boards. Facility signals are also simulated during engine checkout, as well as signals of engine pressure switches, ignition detector, and temperature detector during a simulated firing test. Fuses provide overload protection for the engine electrical control assembly. The simulator panel requires 28 vdc and contains switches, indicating lights, relays, timers, 6 electrical receptacles, a ground connector, and electrical circuitry. Panel 9024480-21 incorporates circuitry to verify the added emergency start tank vent valve circuitry.

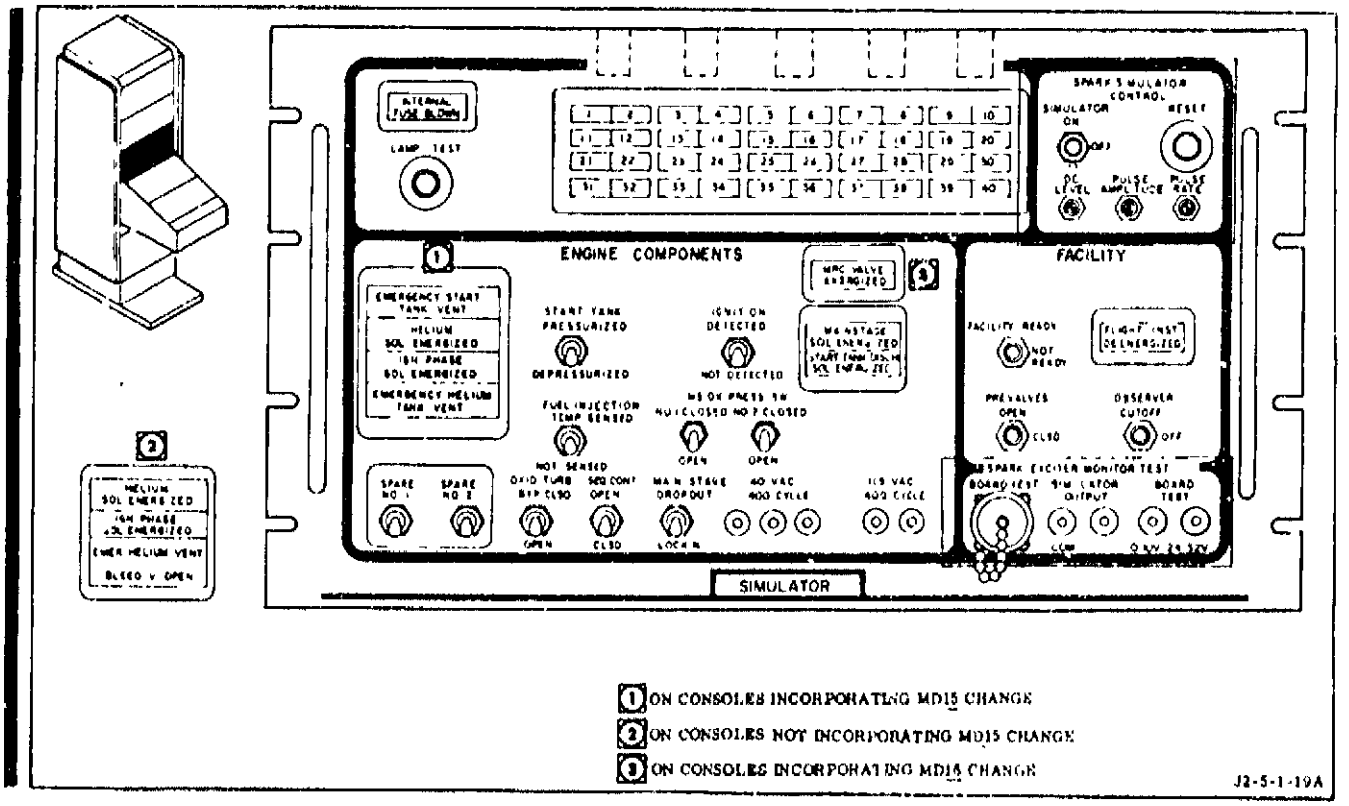


Figure 4-6. Simulator Panel

4-11. SPARK MONITOR PANEL.

4-12. Spark Monitor Panel 9025112-21 (figure 4-7) is an electronic and electromechanical unit which monitors and transmits simulated engine spark system signals to an oscillograph recording console. The panel contains a spark exciter unit, 4 relays, 3 electrical receptacles, and a ground connector. A capacitor added to each of the spark exciter monitor circuit boards attenuates extraneous signals induced from adjacent circuit boards. During operation, the panel receives 28 +2 vdc signal from the ground relay panel and a 6-12 volts peak dc level signal discharging at a minimum pulse rate of 40 discharges per second from the spark simulator. The pulse rate is the discharge rate of the storage capacitor contained within the spark exciter monitor circuitry. The monitor circuit conditions the input signal for oscillograph recording, accepting as a GO signal, a dc level of 6 vdc minimum and a pulse rate of 40 discharges per second minimum. When these parameters are met on the spark exciter monitor, the signal is supplied to a switch, initiating the exciter OK output signal to a relay. The circuitry permits a Spark OK signal only when the engine spark igniters are delivering the rated output.

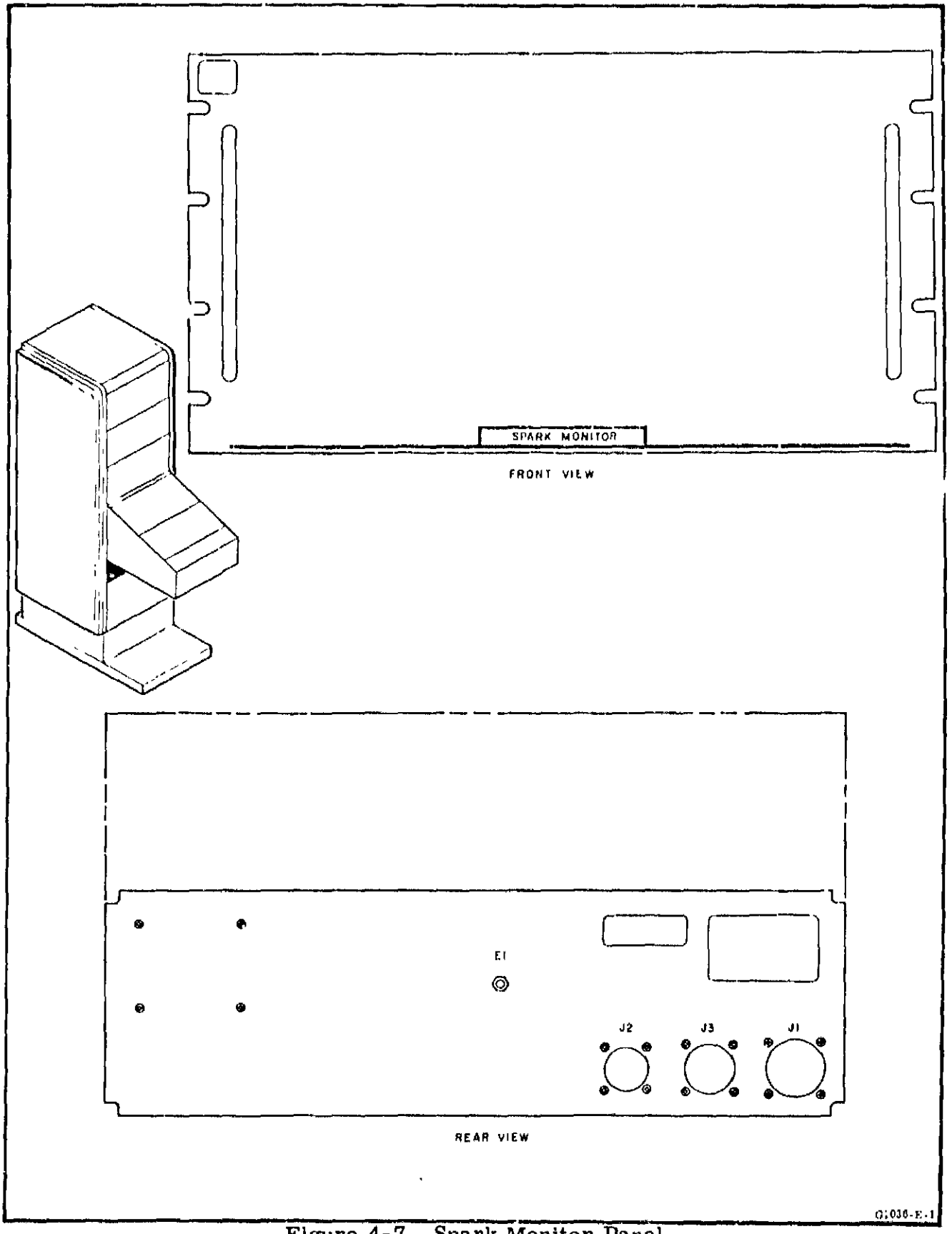


Figure 4-7. Spark Monitor Panel

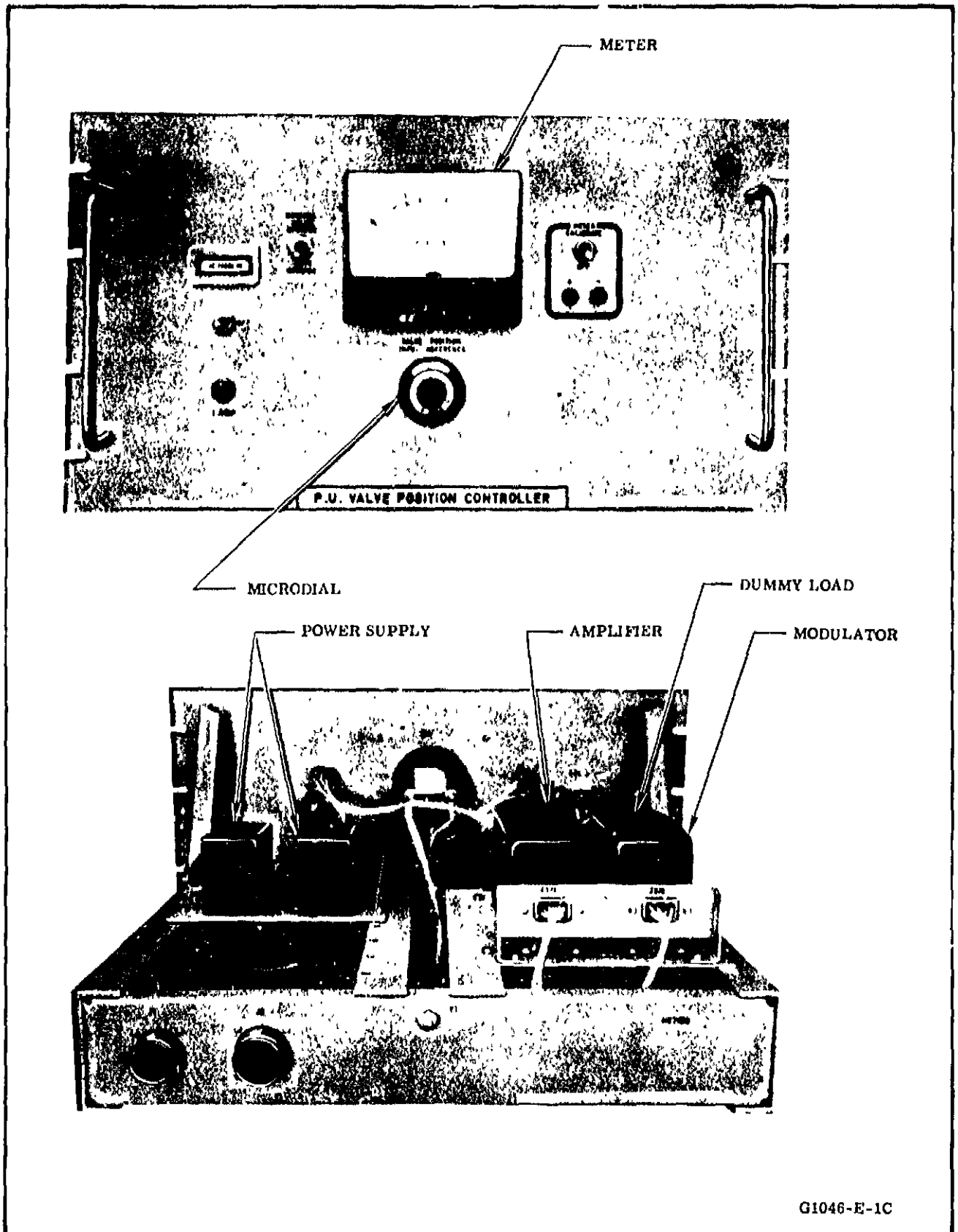


Figure 4-8. Propellant Utilization Valve Position Controller Panel

4-13. PROPELLANT UTILIZATION VALVE POSITION CONTROLLER PANEL.

4-14. Propellant Utilization Valve Position Controller Panel 9025487 (figure 4-8) is an electrical panel which supplies and controls power required to actuate and position the propellant utilization servovalve during engine checkout. It also monitors the control and feedback voltages to and from the servovalve. The panel requires 28 vdc and 115 ±5 vac at 400 ±4 cps, with less than 3 percent harmonic distortion, and contains switches, lights, two 25-vdc power supplies, servocontrol circuitry, 2 electrical receptacles, a ground connector, and a voltmeter graduated from 0 to 100 percent, according to the degree of valve opening.

4-15. ACCESSORIES FOR ELECTRICAL CHECKOUT CONSOLE.

4-16. Accessories consist of engine checkout, self-checkout, and exciter card test cables. See figure 4-9 for accessories and their uses.

Cable	Type	Use
19-9019651	NA5-27093TP208	Engine Checkout
19-9019652	NA5-27093TP209	Self-Checkout
19-9018571	NA5-27093TP281	Engine Checkout
19-9019654	NA5-27093TP211	Self-Checkout
19-9019655	NA5-27093TP212	Self-Checkout and Engine Checkout
19-9019656	NA5-27093TP213	Interconnect to Pneumatic Checkout Console for Engine Checkout
19-9019657	NA5-27093TP214	Self-Checkout
19-9019660	NA5-27093TP217	Engine Checkout
19-9019661	NA5-27093TP224	Checkout of Engine Component Harness
19-9019662	NA5-27093TP225	Engine Checkout (Simulated Firing)
19-9025092	NA5-27093TP261	Engine Checkout (Simulated Firing)

Figure 4-9. Electrical Checkout Console Accessories (Sheet 1 of 2)

Cable	Type	Use
19-9019659	NA5-27093TP226	Checkout of Engine Controller
19-9025091	NA5-27093TP260	Checkout of Engine Controller
9019663	---	Engine Ground Cable
Adapter Assembly 9024512-91	---	Engine Checkout
Adapter Assembly 9024512-101	---	Engine Checkout
Adapter Assembly 9024512-111	---	Engine Checkout
9025779	---	Exciter Card Test
9027453[a]	---	Engine Checkout (Emergency Start Tank Vent Valve)
9027454[a]	---	Engine Checkout (Emergency Start Tank Vent Valve)

(a) On consoles incorporating MD15 change.

Figure 4-9. Electrical Checkout Console Accessories (Sheet 2 of 2)

4-17. THEORY OF OPERATION.

4-18. The electrical checkout console performs a sequence test, a simulated firing test, and component tests, and checks the control package with or without the engine harness. During checkout of the electrical system, the console is used with Flight Instrumentation Checkout Console G1035, Data Recorder Console G3121, and Pneumatic Console G3106. For self-checkout, the cable assemblies are connected to the interface receptacles as shown in figure 4-15. During operation, 28 vdc is supplied to the console interface receptacle J5; 115 vac, 400 cps, is supplied to interface receptacle J4.

4-19. Depressing the main circuit breakers on the ground relay panel and on the engine control panel, and actuating the engine ground power switch on the engine control panel energize the console for operation. Depressing the lamp test switch on the applicable panels performs a lamp test. Turning the key switch on ground relay panel to OK to test, moving the test switch on the engine test/monitor panel to the component-test position, and actuating the facility ready switch on the simulator panel permit individual check of each component circuit by moving the switch on the simulator panel representing the component. Moving the test switch

on the engine test/monitor panel to the sequence-test position energizes a bus which allows current to flow to the engine start switch. Moving the applicable switches to the on position and depressing the engine start switch permit the relays in the circuit to be energized in sequence. This sequence of events is identified by the applicable lights coming on, and continues until the mainstage circuit has been completely checked. The mainstage circuit is deenergized and placed in an operational condition by depressing the cutoff and reset switches. A simulated firing test is accomplished with the key switch on the ground relay panel turned to the area clear position. When the test is performed with Flight Instrumentation Checkout Console G1035, console G1035 shall be in the run mode. When the test is performed without console G1035, a 28-vdc facility source is required at simulator receptacle J10P, to permit a simulated armed test condition by deenergizing the flight instrumentation signal. Energizing the following simulator panel switches arms the system: prevalves, mainstage OK pressure, and start tank. Depressing the engine start switch permits the circuit relays to be energized in sequence and results in panel indications of engine ready. Depressing the observer cutoff button deenergizes the mainstage circuit and places the system in an operational condition.

4-20. CONFIGURATION CHANGES - MANUAL EFFECTIVITY.

4-21. The modifications incorporated changing configuration of the electrical checkout console are listed in figure 4-10.

4-22. To record and provide a means of ready identification of these modifications, the part number of the affected panel is changed and the configuration of the changed console is identified by an MD number. (For an explanation of the MD numbering system, refer to configuration identification in the Introduction.) To determine the part number of a panel or cabinet required for a given console configuration, see figure 4-11.

4-23. MAINTENANCE OF ELECTRICAL CHECKOUT CONSOLE.

4-24. Maintenance tasks required on the electrical checkout console are listed in figure 4-12. Information presented lists the tasks to be performed, when the tasks shall be performed, and reference to data necessary to accomplish these tasks.

4-25. FUNCTION-TESTING ELECTRICAL CHECKOUT CONSOLE.

4-26. Function-testing of the electrical checkout console shall be performed in the order specified and at an ambient temperature of 75° ±25° F. In the event any unspecified result occurs, the test shall be terminated and the defective part repaired or replaced. During function-testing, personnel shall take safety precautions required for use with electrical equipment. Test equipment required to function-test is listed in figure 4-13. See figure 4-14 for console cabling diagram, figure 4-15 for test procedures, and figure 4-16 for timing check. As an aid in function-testing and troubleshooting, see figure 4-17 for interrelationship of panel lights, 4-18 for console electrical schematic, and figures 4-19 through 4-26 for panel and electrical cable wiring diagrams.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-89	1	14 May 1964
J2-134	2	14 May 1964
J2-142	4	14 May 1964
J2-177	3	2 November 1964
J2-215	7	21 May 1965
J2-216	8	21 May 1965
J2-230	6	2 November 1964
J2-273	9	21 May 1965
J2-378	10	16 November 1965
J2-385	11	16 November 1965
J2-418R1	12	21 September 1965
J2-425	13	7 January 1966
J2-441	14	14 April 1966
J2-626	15	20 March 1968
J2-701	16	5 April 1971
J2-701R1	--	2 March 1973

Figure 4-10. Configuration Changes - Manual Effectivity

4-27. Figure 4-15 contains two function tests: A complete test and an abbreviated test. To accomplish the complete test, perform all steps except those not required because of console configuration. An abbreviated test is identical to the complete test except all steps preceded by an asterisk are omitted.

	Engine Test Monitor Panel	Engine Control Panel	Ground Relay Panel	Simulator Panel	Spark Monitor Panel	PU Valve Position Controller Panel	Cabinet
MD16	9024525-41		9025101-61	9025099-61			9025098-31
MD15		9024476-11	9024478-11	9024480-21			
MD14	9024525-31	9018568-11	9025101-51	9025099-51	9025112-21	9025487	9025098-21

To determine part number of panel or cabinet required for a given console configuration, the following method must be used:

1. Obtain MD configuration from console nameplate. (Refer to configuration identification in section I for a description of the MD numbering system.)

2. Read down the column below the panel or cabinet to determine the part number required; the first number on the same line as an incorporated MD change is the correct number.

Figure 4-11. Electrical Checkout Console Panel Configurations

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect console for completeness.	X	X			Refer to paragraph 4-15 for accessories supplied with console.
Inspect electrical cables for: Broken or frayed insulation. Damaged connectors.	X	X			Replace cable or harness.
Paint cabinet or panel.				X	When damaged, paint surfaces with gray enamel (Federal Specification TT-E-529); color 26440 (Federal Standard 595).
Install protective caps on external electrical connectors and receptacles.				X	Whenever connector or receptacle is not in use.
Clean console.				X	As required to maintain cleanness of electrical circuitry. Frequency of cleaning depends on environment in which console is used. Refer to cleaning in section I.
Function-test console.				X	Every six months. Refer to paragraph 4-25 and perform abbreviated test if console has not been repaired, modified, or moved. Function-test completely every 2 years minimum or after repair, modification or moving console.
Cover console.			X		Use greaseproof barrier material (MIL-B-121, Grade A), or equivalent, and seal at bottom edge.
Check continuity of engine checkout cables.				X	Every six months. See figure 4-26.

Figure 4-12. Maintenance Requirements for Electrical Checkout Console

Nomenclature	Part or Model Number	Manufacturer
Multimeter	630-A	Triplett, or equivalent
Differential DC Voltmeter	801	John Fluke Co, or equivalent
Voltmeter, VTVM	1806	General Radio, or equivalent
Oscilloscope	535	Tektronix, or equivalent
Preamp Module	Type 53/54D	Tektronix, or equivalent
Data Recorder Console	G3121	
Frequency Counter Recorder(a)	7150	Beckman, or equivalent
Fuse (Blown) (b)	GLD-1 or GLD-5	Bussmann, or equivalent

(a) Tests spark exciter monitor circuit boards.
(b) Not required when performing abbreviated test.

Figure 4-13. Test Equipment

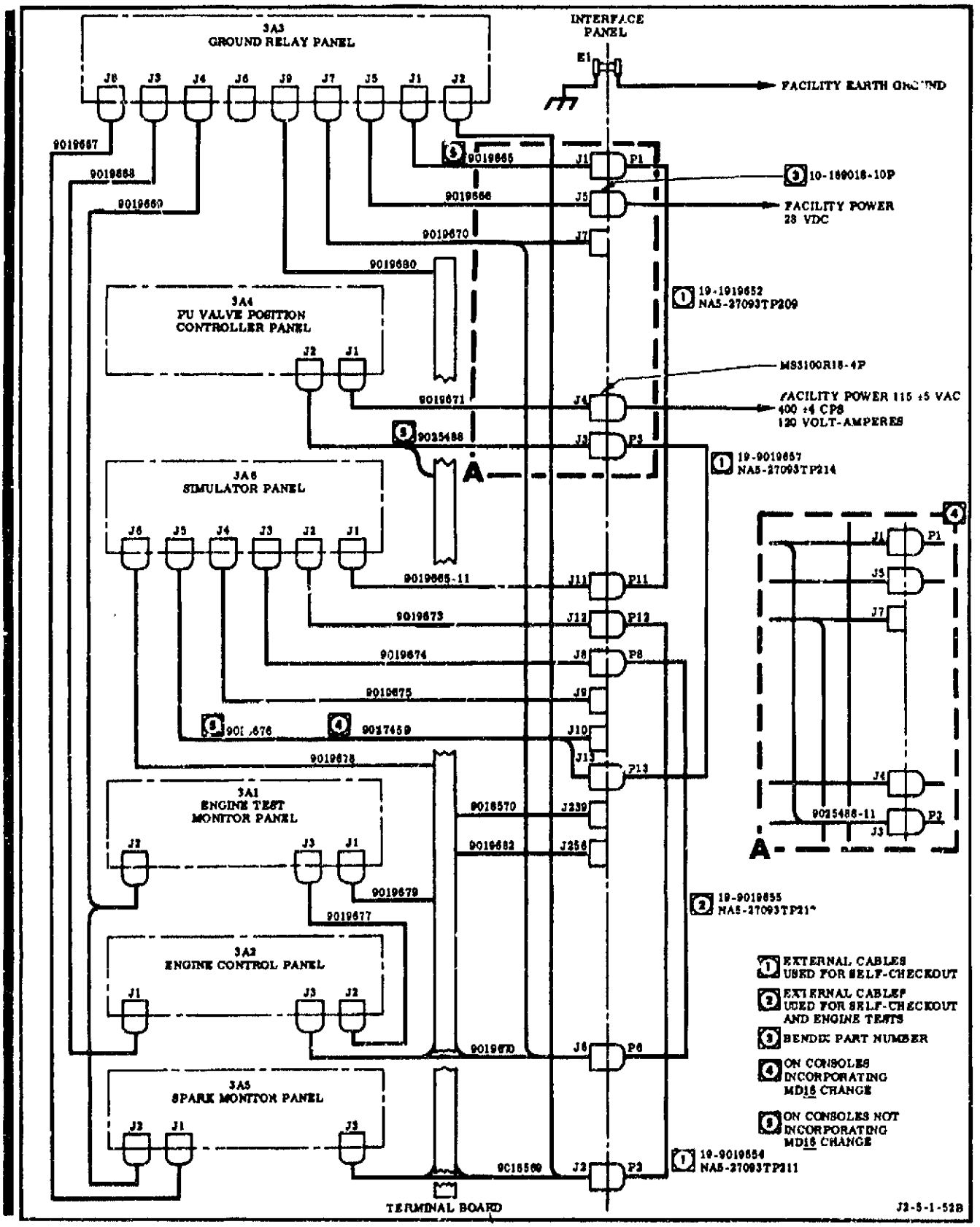


Figure 4-14. Electrical Checkout Console Cabling Diagram

Step	Loc	Operation	Loc	Result

NOTE: Checkout procedures which differ due to console configuration are presented separately. Wherever a step contains multiple procedures, the procedure to be used is the first one encountered under an incorporated MD change number.

- Delete steps preceded by asterisks (*) when performing an abbreviated function-test. See figure 4-12 for requirements for performing full or abbreviated function-tests.
- "Continuity" means a multimeter measurement of less than one ohm. "No continuity" means a measurement of more than ten megohms.
- Only time limits specified in steps 153 and 199 need be recorded. Recording time limits noted in other steps is optional with operator.
- The following abbreviations are used in this figure:

	CTB	Console Terminal Board
	DR	Data Recorder G3121
	EC	Engine Control Panel
	ETM	Engine Test Monitor Panel
	GR	Ground Relay Panel
	IF	Interface Panel
	Loc	Location
	PVPC	Propellant Utilization Valve Position Controller Panel
	S	Simulator Panel
	SM	Spark Monitor Panel
	TE	Test Equipment

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 1 of 43)

Step	Loc	Operation	Loc	Result
1		Obtain test equipment listed in figure 4-13.		
2		Ensure that all switches are at OFF. Switches that do not have an OFF position must be down.		
3		Ensure that all circuit breakers are pulled out.		
4	IF	Connect test cables as shown in figure 4-14.		
5		Install jumper wire from console terminal board TB4-15 to terminal DS13-4 on SIMULATOR panel. This connection establishes a time base for all times specified from ENGINE START. This indication will appear on channel 22 of Recorder Console G3121. Channel 22 will come on with actuation of ENGINE START switch and remains on for approximately 1.5 seconds after switch release.		
6		Ensure that facility power is supplied to console. See figure 4-2 for requirements.		
7	GR	Depress 28 VDC POWER circuit breaker.		No visible results.
8	S	Move SPARE NO. 1 switch up.		No visible results.
9	S	Move SPARE NO. 2 switch up.		No visible results.
10	EC	Move switch immediately below ENGINE GROUND POWER light momentarily to ON, then return to OFF.		No visible results.
11	EC	Depress ENGINE POWER circuit breaker.	S	8 light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 2 of 43)

Step	Loc	Operation	Loc	Result
12	EC	Depress and hold LAMP TEST switch.	EC	All lights on.
13	EC	Release LAMP TEST switch.	EC	All lights off.
14	ETM	Depress and hold LAMP TEST switch.	ETM	All lights on.
15	ETM	Release LAMP TEST switch.	ETM	All lights off.
16	EC	Move switch immediately below ENGINE GROUND POWER light to ON.	EC	ENGINE GROUND POWER light on.
				MAINSTAGE OK NO. 1 DE-PRESSURIZED light on.
				MAINSTAGE OK NO. 2 DE-PRESSURIZED light on.
				ENGINE BUS VOLTAGE meter indicates 24-30 vdc.
			ETM	START TANK DEPRESSURIZED light on.
				IGNITION BUS ARMED light on.
			S	FLIGHT INST. DE-ENERGIZE light on.
				19, 28, 32, and 33 lights on.
17	ETM	Check voltage between COM and ENGINE.	TE	4.5 ±0.5 vdc.
18	ETM	Check voltage between COM and IGNITION.	TE	4.5 ±0.5 vdc.
*19	TF	Check voltage between J256-11 (neg) and J256-20, 25, 31, and 45 (pos).	TE	20-30 vdc.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 3 of 43)

Step	Loc	Operation	Loc	Result
*20	S	Check continuity between: a. J21-B and COM jack; b. J21-A and 24-32V jack; c. J21-F and 0.10V jack; d. J21-G and SIMULATOR OUTPUT red jack; e. J21-H and J21-K.	TE	Continuity.
21	IF	Check continuity between: a. J10-G and J10-J; b. J10-H and J10-S.	TE	Continuity.
*22	IF	Check continuity between: a. J10-T and J9-S; b. J256-11 and J256-13; c. J256-11 and J256-15; d. J256-11 and J256-16; e. J256-8 and J256-9, 10, 12, and 56, and with each other.	TE	Continuity.
23	GR	Pull out 28 VDC POWER circuit breaker.		All lights off.
24		Connect cable assembly NA5-27093TP216 between electrical checkout console receptacle J256 and data recorder console receptacle J255.		
25		Activate event recorder on Data Recorder Console G3121 and set chart speed switch to 0.05.		

NOTE: The event recorder shall verify signal inputs from the electrical checkout console.

26	GR	Depress 28 VDC POWER circuit breaker.	EC	ENGINE GROUND POWER light on. MAINSTAGE OK NO. 1 DEPRESSURIZED light on. MAINSTAGE OK NO. 2 DEPRESSURIZED light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 4 of 43)

Step	Loc	Operation	Loc	Result
			ETM	IGNITION BUS ARMED light on.
				START TANK DEPRESSURIZED light on.
			S	FLIGHT INST. DE-ENERGIZE light on.
				8, 19, 28, 32, and 33 lights on.
			DR	Pens 19, 28, 32, and 33 deflect on.
				Pen 60 deflects on and off.
27	EC	Move BUS SELECT switch to CONTROL.	EC	ENGINE BUS VOLTAGE meter indicates 24-30 vdc.
28	EC	Pull out ENGINE POWER circuit breaker.		All lights off.
			DR	Pens deflected on deflect off.
29	EC	Depress ENGINE POWER circuit breaker.		Step 26 results repeated.
30	S	Depress and hold LAMP TEST switch.	S	All lights on.
31	S	Release LAMP TEST switch.	S	All lights off except 8, 19, 28, 32, and 33.
		MD15 Change		MD15 Change
32	EC	Move switch immediately below EMERGENCY HELIUM TANK VENT light to ON.	EC	EMERGENCY HELIUM TANK VENT light on.
			S	EMERGENCY HELIUM TANK VENT light on.
		MD14 Change		MD14 Change
	EC	Move switch immediately below EMERGENCY HELIUM TANK VENT light to ON.	EC	EMERGENCY HELIUM TANK VENT light on.
			S	EMER HELIUM VENT BLEED V OPEN light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 5 of 43)

Step	Loc	Operation	Loc	Result
33		(Deleted)		
		MD15 Change		MD15 Change
34	EC	Move switch immediately below EMERGENCY START TANK VENT light to OPEN.	EC	EMERGENCY START TANK VENT light on.
			S	EMERGENCY START TANK VENT light on.
		MD14 Change		MD14 Change
	EC	Move switch immediately below BLEED VALVE ENERGIZED light to OPEN.	EC	BLEED VALVE ENERGIZED light on.
			S	EMER HELIUM VENT BLEED V OPEN light on.
35	IF	Check continuity between: a. J9-H and J9-J; b. J9-K and J9-L.	TE	No continuity.
*36	GR	Remove ENGINE CONTROL 10A fuse.	EC	ENGINE GROUND POWER light off. ENGINE BUS VOLTAGE meter indicates zero.
*37	GR	Remove ENGINE IGNITION 1A fuse.	ETM	IGNITION BUS ARMED light off.
*38	GR	Remove PNEU CONSOLE 10A S/B fuse.		No visible results.
				MD15 Change
*39	GR	Remove EMER HELIUM 5A fuse.	S	EMERGENCY HELIUM TANK VENT light off. EMERGENCY START TANK VENT light off.
				MD14 Change
				EMER HELIUM VENT BLEED V OPEN light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 6 of 43)

Step	Loc	Operation	Loc	Result
*40	GR	Remove HELIUM CONTROL 5A fuse.		No visible results.
*41	IF	Install jumper wires between: a. J9-P and J9-R; b. J9-T and J9-U; c. J7-A and J7-C.		No visible results.
*42	S	Remove lamp from HELIUM SOL. ENERGIZED lampholder.		
*43	GR	Reinstall fuseholder caps only on: a. ENGINE CONTROL 10A. b. ENGINE IGNITION 1A. c. PNEU CONSOLE 10A S/B. d. EMER HELIUM 5A.	GR EC	Lights in caps on. ENGINE BUS VOLTAGE meter indicates less than 10 vdc when ENGINE CONTROL 10A cap is installed.
*44	GR	Remove fuseholder caps installed in step 43.		Step 43 results reversed.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 7 of 43)

Step	Loc	Operation	Loc	Result
*45	IF	Remove jumper wires between: a. J9-P and J9-R; b. J7-A and J7-C.		No visible results.
*46		Reverse steps 36 through 39.		Lights turned off come on.
			EC	ENGINE BUS VOLTAGE meter indicates 24-30 vdc.
*47	GR	Install fuseholder cap only on HELIUM CONTROL 5A.		No visible results.
48	GR	Move TEST/FIRE SELECT switch to OK TO TEST.		No visible results.
49	S	Move FACILITY READY switch to READY.	EC	FACILITY READY light on.
50	EC	Depress TEST POWER circuit breaker.	EC	TEST light on.

NOTE: In the following step, record the voltage obtained between COM and 1 of MULTIPLEX OUTPUT MONITOR 0-5 VDC. This voltage is referred to as voltage A and is used to determine multiplex voltages in later steps.

- Use differential DC voltmeter to measure multiplex voltages during remainder of test.

51	ETM	Check voltage between: a. COM and 1; b. COM and 4.	TE	1.6 ±0.20 vdc.
52	ETM	Move switch immediately above COMPONENT TEST light down.	ETM	COMPONENT TEST light on.
			GR	CUTOFF light on.
			EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
			S	6, 39, and 40 lights on.
			DR	Pens 39 and 40 deflect on.
*53	ETM	Move HELIUM CONTROL switch to ON.	GR	HELIUM CONTROL 5A fuseholder light on.
*54	ETM	Move HELIUM CONTROL switch to OFF.	GR	HELIUM CONTROL 5A fuseholder light off.
*55	IF	Remove jumper wire from J9-T and J9-U.		No visible results.
*56	GR	Replace HELIUM CONTROL 5A fuse.		No visible results.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 8 of 43)

Step	Loc	Operation	Loc	Result
*57	S	Replace lamp in HELIUM SOL ENERGIZED lampholder.		
		MD15 Change		MD15 Change
58	EC	Move switch immediately below EMERGENCY HELIUM TANK VENT light to OFF.	EC	EMERGENCY HELIUM TANK VENT light off.
			S	EMERGENCY HELIUM TANK VENT light off.
		MD14 Change		MD14 Change
		Move switch immediately below BLEED VALVE ENERGIZED light to CLOSED.	EC	BLEED VALVE ENERGIZED light off.
			S	EMER HELIUM VENT BLEED V OPEN light off.
		MD15 Change		MD15 Change
58A	EC	Move switch immediately below EMERGENCY START TANK VENT light to CLOSED.	EC	EMERGENCY START TANK VENT light off.
			S	EMERGENCY START TANK VENT light off.
59	ETM	Check voltage between test jacks COM and 3.	TE	Voltage A X 1.04 ±5 percent.
60	ETM	Check voltage between test jacks COM and 2.	TE	Voltage A X 1.18 ±5 percent.
*61	S	Remove fuses from fuseholders F1 through F11 on rear of simulator panel.		
*62	S	Install blown fuse into fuseholder F1.		
		MD16 Change		
*63	IF	Connect jumper wire between TB4-6 (+28 vdc) and J9-K.	S	INTERNAL FUSE BLOWN light on.
		MD15 Change		F1 indicator light on.
		Connect jumper wire between TB4-14 (+28 vdc) and J9-K.		
*64	IF	Remove jumper wire from pin J9-K only, and check continuity between pins J9-K and J9-L.	TE	No continuity.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 9 of 43)

Step	Loc	Operation	Loc	Result
NOTE: Whenever the jumper wire is removed, the INTERNAL FUSE BLOWN light and respective fuse indicator light go off.				
*65	S	Remove blown fuse from fuseholder F1, install in fuseholder F2, and connect jumper wire to J9-H.	S	INTERNAL FUSE BLOWN light on. F2 indicator light on.
*66	IF	Remove jumper wire from pin J9-H only, and check continuity between pins J9-H and J9-J.	TE	No continuity.
*67	S	Remove blown fuse from fuseholder F2, install in fuseholder F3, and connect jumper wire to TB4-8.	S	INTERNAL FUSE BLOWN light on. F3 indicator light on.
*68	S	Remove jumper wire from TB4-8 and check resistance between TB4-8 and TB4-10.	TE	Minimum 900 ohms.
*69	S	Remove blown fuse from fuseholder F3, install in fuseholder F4, and connect jumper wire to pin J9-T.	S	INTERNAL FUSE BLOWN light on. F4 indicator light on.
*70	IF	Remove jumper wire from pin J9-T.		
*71	S	Remove blown fuse from fuseholder F4, install in fuseholder F5, and connect jumper wire to pin J9-X.	S	INTERNAL FUSE BLOWN light on. F5 indicator light on.
*72	IF	Remove jumper wire from pin J9-X.		

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 10 of 43)

Step	Loc	Operation	Loc	Result
*73	S	Remove blown fuse from fuseholder F5, install in fuseholder F6, and connect jumper wire to pin J9-V.	S	INTERNAL FUSE BLOWN light on. F6 indicator light on.
*74	IF	Remove jumper wire from pin J9-V.		
*75	S	Remove blown fuse from fuseholder F6, install in fuseholder F7, and connect jumper wire to pin J10-P.	S	INTERNAL FUSE BLOWN light on. F7 indicator light on.
*76	IF	Remove jumper wire from pin J10-P. Check continuity between pins J10-P and J10-N.	TE	No continuity.
*77	S	Remove blown fuse from fuseholder F7, install in fuseholder F8, and connect jumper wire to pin J9-M.	S	INTERNAL FUSE BLOWN light on. F8 indicator light on.
*78	IF	Remove jumper wire from pin J9-M and check continuity between pins J9-M and J9-N.	TE	No continuity.
*79	S	Remove blown fuse from fuseholder F8, install in fuseholder F9, and connect jumper wire to pin J9-Z.	S	INTERNAL FUSE BLOWN light on. F9 indicator light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 11 of 43)

Step	Loc	Operation	Loc	Result
*80	IF	Remove jumper wire from pin J9-Z.		
*81	S	Remove blown fuse from fuseholder F9, install in fuseholder F10, and connect jumper wire to pin J10-S.	S	INTERNAL FUSE BLOWN light on. F10 indicator light on.
*82	IF	Remove jumper wire from pin J10-S and check resistance between pins J10-S and J10-H.		Minimum 1 K ohms.
*83	S	Remove blown fuse from fuseholder F10, install in fuseholder F11, and connect jumper wire to pin J10-J.	S	INTERNAL FUSE BLOWN light on. F11 indicator light on.
*84	IF	Remove jumper wire from pin J10-J and check continuity between pins J10-J and J10-G.	TE	No continuity.
*85	S	Remove blown fuse from fuseholder F11 and install fuses F1 through F11.		
86	S	Connect VTVM, frequency counter and oscilloscope with pre-amp plug-in module to SIMULATOR OUTPUT jacks. Connect (neg) leads to COM jack.		No visible results.
CAUTION: Steps 87 through 89 must be completed within 10 minutes, or damage to equipment can result. If not completed within 10 minutes, temporarily discontinue test by moving SIMULATOR switch to OFF. Wait a minimum of 3 minutes, move SIMULATOR switch to ON, and resume test.				
87	S	Move SIMULATOR switch to ON.	ETM	NO. 1 ASI SPARK light on. NO. 2 ASI SPARK light on. NO. 1 GG SPARK light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 12 of 43)

Step	Loc	Operation	Loc	Result
				NO. 2 GG SPARK light on.
			S	23, 24, 25, and 26 lights on.
			DR	Pens 23, 24, 25, and 26 deflect on.
			TE	VTVM indicates 6.5 ±0.10 vdc.
				Oscilloscope indicates 1-2 volts above dc level, at a rate of 24-26 milliseconds per pulse.
				Frequency counter indicates 40 ±1 pulses per second.

NOTE: One or more of the required results of step 87 may not be obtained. Do not terminate the test, since later adjustments may correct this condition.

- If results of step 87 are obtained, proceed directly to step 91. If test equipment in step 87 indicates correct values but one or more lights are not on, perform step 88 to adjust or replace malfunctioning circuit boards. If test equipment in step 87 does not indicate correct values, proceed to step 89.

88		Remove and adjust or replace malfunctioning circuit boards, then continue test with step 90. Refer to paragraph 4-34 for removal procedures, and paragraph 4-36 for test and adjustment procedures.		
89	S	Adjust SPARK SIMULATOR CONTROL as follows: Momentarily depress RESET after each adjustment to check for results. a. Adjust DC LEVEL to obtain 6.5 ±0.10 vdc on VTVM. b. Adjust PULSE RATE to obtain 40 ±1 pulses per second on frequency counter. c. Adjust PULSE AMPLITUDE to obtain a 1-2 volt pulse above dc level on oscilloscope.		Same as in step 87.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 13 of 43)

Step	Loc	Operation	Loc	Result
NOTE: Loosen locknuts to make adjustments, then retighten sufficiently to prevent inadvertent movement of adjustment screw. Results must be obtained with locknuts tightened. If results of step 89 are obtained, proceed to step 91.				
90		Upon installation of new or adjusted circuit boards, reactivate the console by positioning the following controls as noted and repeating the test starting with step 86.		
		a. Ensure that all circuit breakers are pulled out and all switches are at off or, if not placarded OFF, to the lowermost position.		All lights off and meters indicate zero.
	GR	b. Depress 28 VDC POWER circuit breaker.		No visible results.
	S	c. Move SPARE NO. 1 and SPARE NO. 2 switches up.		No visible results.
	EC	d. Depress ENGINE POWER circuit breaker.	S	8 light on.
	EC	e. Move switch immediately below ENGINE GROUND POWER light to ON.	EC	ENGINE GROUND POWER light on.
				MAINSTAGE OK NO. 1 DEPRESSURIZED light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light on.
				ENGINE BUS VOLTAGE meter 24-30 vdc.
			ETM	START TANK DEPRESSURIZED light on.
				IGNITION BUS ARMED light on.
			S	FLIGHT INST. DE-ENERGIZE light on.
				19, 28, 32, and 33 lights on.
			DR	Pens 19, 28, 32, and 33 deflect on.
	EC	f. Move BUS SELECT switch to CONTROL.		No visible results

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 14 of 43)

Step	Loc	Operation	Loc	Result
	S	g. Move FACILITY READY switch to READY.	EC	FACILITY READY light on.
	GR	h. Move TEST/FIRE SELECT switch to OK TO TEST.		No visible results.
	EC	i. Depress TEST POWER circuit breaker.	EC	TEST light on.
	ETM	j. Move switch immediately below SEQUENCE TEST light down.	ETM	COMPONENT TEST light on.
			EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
			GR	CUTOFF light on.
			S	6, 39, 40 lights on.
			DR	Pens 39 and 40 deflect on.
*91	S	Check voltage between J21-E (pos) and SIMULATOR OUTPUT COM jack.	TE	24-30 vdc.
92	S	Move SIMULATOR switch to OFF.	ETM	NO. 1 ASI SPARK light off.
				NO. 2 ASI SPARK light off.
				NO. 1 GG SPARK light off.
				NO. 2 GG SPARK light off.
			S	23, 24, 25, and 26 lights off.
			DR	Pens 23, 24, 25, and 26 deflect off.
			TE	Signals disappear.
93	S	Disconnect test equipment from SIMULATOR OUTPUT jacks.		
94	ETM	Move HELIUM CONTROL switch to ON.	ETM	HELIUM CONTROL light on.
			S	HELIUM SOL. ENERGIZED light on.
				4 light on.
			DR	Pen 4 deflects on.
95	IF	Check voltage between J9-T (pos) and J9-U (neg).	TE	24-30 vdc.
96	ETM	Check voltage between test jacks COM and 1.	TE	Voltage A X 1.44 ±5 percent.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 15 of 43)

Step	Loc	Operation	Loc	Result
97	ETM	Move IGNITION PHASE CONTROL switch to ON.	ETM	IGNITION PHASE CONTROL light on.
			S	IGN. PHASE SOL. ENFRGIZED light on.
				5 light on.
			DR	Pen 5 deflects on.
*98	IF	Check voltage between J9-X (pos) and J9-Y (neg).	TE	24-30 vdc.
99	ETM	Check voltage between test jacks COM and 1.	TE	Voltage A X 1.69 ±5 percent.
100	ETM	Move SPARK CONTROL switch up a maximum of 3 seconds.		No visible results.
101	ETM	Move IGNITION PHASE CONTROL switch to OFF.	ETM	IGNITION PHASE CONTROL light off.
			S	IGN. PHASE SOL. ENERGIZED light off.
				5 light off.
			DR	Pen 5 deflects off.
102	ETM	Connect multimeter between COM and 3 test jacks.		
103	ETM	Move SPARK CONTROL switch up for a minimum of 7 seconds.		Voltage A X 1.39 ±5 percent.
			ETM	NO. 1 ASI SPARK light on.
				NO. 1 GG SPARK light on.
			S	23 and 25 lights on.
			DR	Pens 23 and 25 deflect on.

NOTE: Results in step 103 occur for approximately 5 seconds then return to off.

- Perform step 104 immediately after lights go off in step 103.

104	ETM	Move SPARK CONTROL switch up momentarily several times for 3 minutes.		Results of step 103 shall not re-occur.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 16 of 43)

Step	Loc	Operation	Loc	Result
105	ETM	Disconnect multimeter from COM and 3 test jacks.		
106	ETM	Move SPARK CONTROL switch down for a minimum of 7 seconds.	ETM	NO. 2 ASI SPARK light on.
				NO. 2 GG SPARK light on.
			S	24 and 26 lights on.
			DR	Pens 24 and 26 deflect on.

NOTE: Results in step 106 occur for approximately 5 seconds then return to off.

- Perform step 107 immediately after lights go off in step 106.

107	ETM	Move SPARKS CONTROL switch down momentarily several times for next 3 minutes.		Results of step 106 shall not re-occur.
108	ETM	Move IGNITION PHASE CONTROL switch to ON.	ETM	IGNITION PHASE CONTROL light on.
			S	IGN. PHASE SOL. ENERGIZED light on.
				5 light on.
			DR	Pen 5 deflects on.
109	ETM	Move START TANK DISCHARGE CONTROL switch to ON.	ETM	START TANK DISCH. CONTROL light on.
			S	START TANK DISCH. SOL. ENERGIZED light on.
				9 light on.
			DR	Pen 9 deflects on.
*110	IF	Check voltage between J9-V (pos) and J9-W (neg).	TE	20-30 vdc.
111	ETM	Check voltage between test jacks COM and 1.	TE	Voltage A X 1.86 ±5 percent.
112	ETM	Move MAINSTAGE CONTROL switch to ON.	ETM	MAINSTAGE CONTROL light on.
			S	MAINSTAGE SOL. ENERGIZED light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 17 of 43)

Step	Loc	Operation	Loc	Result
				12, 14 and 18 lights on.
				19 light off.
			DR	Pens 12, 14, and 18 deflect on.
				Pen 19 deflects off.
*113	IF	Check voltage between J9-Z (pos) and J9-a (neg).	TE	20-30 vdc.
114	IF	Check voltage between J7-D (pos) and J7-C (neg).	TE	Zero.
115	ETM	Check voltage between test jacks COM and 1.	TE	Voltage A X 3.12 ±5 percent.
116	S	Move and hold MAINSTAGE switch to DROPOUT.	S	12 light off.
			ETM	MAINSTAGE CONTROL light off.
			DR	Pen 12 deflects off.
117	S	Release MAINSTAGE switch.	S	12 light on.
			ETM	MAINSTAGE CONTROL light on.
			DR	Pen 12 deflects on.
118	ETM	Move IGNITION PHASE CONTROL switch to OFF.	ETM	IGNITION PHASE CONTROL light off.
			S	IGN. PHASE SOL. ENERGIZED light off.
				5 light off.
			DR	Pen 5 deflects off.
119	ETM	Move SPARK CONTROL switch up and down. Hold maximum of 3 seconds in each position.		No visible results.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 18 of 43)

Step	Loc	Operation	Loc	Result
120	ETM	Move IGNITION PHASE CONTROL switch to ON.	ETM	IGNITION PHASE CONTROL light on.
			S	IGN. PHASE SOL. ENERGIZED light on.
				5 light on.
			DR	Pen 5 deflects on.
121	ETM	Move MAINSTAGE INITIATED switch ON.		No visible results.
		MD16 Change		
121A	ETM	Move MRC VALVE switch to OPEN.	ETM	MRC VALVE ENERGIZED light on.
			S	MRC VALVE ENERGIZED light on.
122	IF	Check voltage between J7-D (pos) and J7-C (neg).	TE	24-30 vdc.
				MD16 Change
123	S	Move PREVALVES switch to OPEN.	S	HELIUM SOL. ENERGIZED light off.
				IGN. PHASE SOL. ENERGIZED light off.
				START TANK DISCH. SOL. ENERGIZED light off.
				MAINSTAGE SOL. ENERGIZED light off.
				MRC VALVE ENERGIZED light off.
				4, 5, 9, 12, 14, and 18 lights off.
				19 light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 19 of 43)

Step	Loc	Operation	Loc	Result
			ETM	COMPONENT TEST light off.
				HELIUM CONTROL light off.
				IGNITION PHASE CONTROL light off.
				START TANK DISCH. CONTROL light off.
				MRC VALVE ENERGIZED light off.
				MAINSTAGE CONTROL light off.
			EC	TEST light off.
			DR	Pens 4, 5, 9, 12, 14, and 18 deflect off.
				Pen 19 deflects on.
				MD14 Change
			S	HELIUM SOL. ENERGIZED light off.
				IGN. PHASE SOL. ENERGIZED light off.
				START TANK DISCH. SOL. ENERGIZED light off.
				MAINSTAGE SOL. ENERGIZED light off.
				4, 5, 9, 12, 14, and 18 lights off.
				19 light on.
			ETM	COMPONENT TEST light off.
				HELIUM CONTROL light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 20 of 43)

Step	Loc	Operation	Loc	Result
				IGNITION PHASE CONTROL light off.
				START TANK DISCH. CONTROL light off.
				MAINSTAGE CONTROL light off.
			EC	TEST light off.
			DR	Pens 4, 5, 9, 12, 14, and 18 deflect off.
				Pen 19 deflects on.

NOTE: Conditions in step 124 occur when the switch is depressed and revert when the switch is released.

124	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
			S	39 light off.
			DR	Pen 39 deflects off.
125	ETM	Move switch immediately below SEQUENCE TEST light up.		No visible results.
				MD16 Change
126	S	Move PREVALVES switch to CLOSED.	S	MRC VALVE ENERGIZED light on.
			EC	TEST light on.
			ETM	SEQUENCE TEST light on.
				MRC VALVE ENERGIZED light on.
				MD14 Change
			EC	TEST light on.
			ETM	SEQUENCE TEST light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 21 of 43)

Step	Loc	Operation	Loc	Result
		MD16 Change		
126A	ETM	Check voltage between test jacks COM and 4.	TE	Voltage A X 1.46 ±5 percent.
		MD16 Change		
126B	ETM	Move MRC VALVE switch to CLOSED.	ETM	MRC VALVE ENERGIZED light off.
			S	MRC VALVE ENERGIZED light off.
127	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			S	6, 39, and 40 light off.
			DR	Pens 39 and 40 deflect off.
128	ETM	Move switch immediately below IGNITION BUS ARMED light to DISARMED.	ETM	IGNITION BUS ARMED light off.
129	EC	Move BUS SELECT switch to IGNITION.	EC	ENGINE BUS VOLTAGE meter indicates zero.
130	ETM	Move TEMP DETECTOR switch to BYPASS.		No visible results.
131	S	Move IGNITION switch to DETECTED.		No visible results.
132	IF	Check resistance between J10-W and J10-c.	TE	200 ±20 ohms.
133	ETM	Move IGNITION COMPLETE BYPASS switch to ON.	ETM	IGNITION COMPLETE light on.
			S	29 light on.
			DR	Pen 29 deflects on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 22 of 43)

Step	Loc	Operation	Loc	Result
134	ETM	Move MAINSTAGE OK BYPASS switch to ON.	ETM	MAINSTAGE OK light on.
			EC	MAINSTAGE OK NO. 1 PRESSURIZED light on.
				MAINSTAGE OK NO. 2 PRESSURIZED light on.
			S	30 and 31 lights on.
			DR	Pens 30 and 31 deflect on.
135	EC	Momentarily depress ENGINE START switch.	ETM	START TANK DISCH. CONTROL light on momentarily.
			S	START TANK DISCH. SOL. ENERGIZED light on momentarily.
				3, 7, and 9 lights on momentarily.
			DR	Pens 3 and 9 deflect on momentarily.
			ETM	HELIUM CONTROL light on.
				IGNITION PHASE CONTROL light on.
				MAINSTAGE CONTROL light on.
			S	HELIUM SOL. ENERGIZED light on.
				IGN. PHASE SOL. ENERGIZED light on.
				MAINSTAGE SOL. ENERGIZED light on.
				4, 5, 12, 14, and 18 lights on.
				19 light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 23 of 43)

Step	Loc	Operation	I oc	Result
			DR	Pens 4, 5, 12, 14, and 18 deflect on. Pen 22 deflects on momentarily. Pen 19 deflects off.
136	IF	Check continuity between: a. J9-M and J9-N; b. J10-N and J10-P.	TE	No continuity.
137	IF	Check resistance between: a. J10-W and J10-b; b. J10-W and J10-c.	TE	 100 ±10 ohms. 236 ±24 ohms.

NOTE: In step 138 the first 4 results occur approximately one second after depressing CUTOFF switch.

138	EC	Momentarily depress CUTOFF switch.	ETM	HELIUM CONTROL light off.
			S	HELIUM SOL. ENERGIZED light off.
				4 light off.
			DR	Pen 4 deflects off.
			EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
			GR	CUTOFF light on.
			ETM	IGNITION PHASE CONTROL light off.
				IGNITION COMPLETE light off.
				MAINSTAGE CONTROL light off.
			S	IGN. PHASE SOL. ENERGIZED light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 24 of 43)

Step	Loc	Operation	Loc	Result
				6, 19, 39, and 40 lights on.
				5, 12, 14, 18, and 29 lights off.
			DR	Pens 19, 39, and 40 deflect on.
				Pens 5, 12, 14, 18, and 29 deflect off.
139	IF	Check continuity between J9-M and J9-N.	TE	Continuity.
140	S	Move SEQ. CONTROL switch to OPEN.		No visible results.
*141	IF	Check continuity between J9-M and J9-N.	TE	No continuity.
142	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			ETM	IGNITION COMPLETE light on.
			S	29 light on.
				6, 39, and 40 lights off.
			DR	Pen 29 deflects on.
				Pens 39 and 40 deflect off.
143	ETM	Move TEMP DETECTOR switch to TEMP OK BY-PASS.	ETM	FUEL INJECTION TEMPERATURE OK light on.
			S	1 light on.
			DR	Pen 1 deflects on.
144		Repeat steps 135, 138, and 142.		Same as in steps 135, 138, and 142.
145	ETM	Move TEMP DETECTOR switch to OFF.	ETM	FUEL INJECTION TEMPERATURE OK light off.
			S	1 light off.
			DR	Pen 1 deflects off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 25 of 43)

Step	Loc	Operation	Loc	Result
146	IF	Check resistance between J10-Y and J10-Z.	TE	1,430-1,750 ohms.
147	S	Move FUEL INJECTION TEMP switch to SENSED.	S	1 light on.
			DR	Pen 1 deflects on.
			ETM	FUEL INJECTION TEMPERATURE OK light on.
*148	IF	Check continuity between J10-Z and J10-a.		Continuity.
149	IF	Check resistance between: a. J10-Y and J10-a; b. J10-Y and J10-Z.		618-748 ohms.
150		Repeat steps 135, 138, and 142.		Same as in steps 135, 138, and 142.
151	ETM	Move MAINSTAGE OK BYPASS switch to OFF.	ETM	MAINSTAGE OK light off.
			EC	MAINSTAGE OK NO. 1 PRESSURIZED light off.
				MAINSTAGE OK NO. 2 PRESSURIZED light off.
			S	30 and 31 lights off.
			DR	Pens 30 and 31 deflect off.
152	DR	Set chart speed at NO. 125 on the event recorder prior to performing step 153. After completion of the step, deenergize the event recorder.		

NOTE: There is no requirement in step 153 to verify condition of lights. Their condition (on or off) is directly related to the associated pen on the event recorder. See figure 4-17 for information on the interrelation of panel indicators. Lights without associated pens are listed, and their conditions noted, for reference purposes only.

153	EC	Momentarily depress ENGINE START switch.	DR	Event recorder indicates on and off cycling, as shown in sequence A of figure 4-16.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 26 of 43)

Step	Loc	Operation	Loc	Result
			S	3 and 7 lights on momentarily when ENGINE START switch is depressed.
				HELIUM SOL. ENERGIZED light cycles with pen 4 of event recorder.
				IGN. PHASE SOL. ENERGIZED light cycles with pen 5 of event recorder.
				START TANK DISCH. SOL. ENERGIZED light cycles with pen 9 of event recorder.
				MAINSTAGE SOL. ENERGIZED light cycles with pen 12 of event recorder.
			GR	CUTOFF light cycles with pen 39 of event recorder.
154	S	Move MAINSTAGE OK PRESSURE SW NO. 1 to CLOSED.		No visible results.
155	IP	Check continuity between J10-H and J10-S.	TE	Continuity.
156	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			ETM	IGNITION COMPLETE light on.
			GR	CUTOFF light off.
			S	29 light on.
				6, 39, and 40 lights off.
157	EC	Momentarily depress ENGINE START switch.	EC	MAINSTAGE OK NO. 1 PRESSURIZED light on.
				MAINSTAGE OK NO. 2 PRESSURIZED light on.
				MAINSTAGE OK NO. 1 DEPRESSURIZED light off.
			ETM	HELIUM CONTROL light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 27 of 43)

Step	Loc	Operation	Loc	Result
				IGNITION PHASE CONTROL light on.
				START TANK DISCH. CONTROL light on momentarily.
				MAINSTAGE CONTROL light on.
				MAINSTAGE OK light on.
			S	HELIUM SOL. ENERGIZED light on.
				IGN. PHASE SOL. ENERGIZED light on.
				START TANK DISCH. SOL. ENERGIZED light on momentarily.
				MAINSTAGE SOL. ENERGIZED light on.
				4, 5, 12, 14, 18, 30, and 31 lights on.
				19 and 32 lights off.
				3, 7 and 9 lights on momentarily.
158	IF	Check continuity between: a. J10-R and J10-S; b. J10-H and J10-S.	TE	a. Continuity b. No continuity.
159	EC	Momentarily depress CUTOFF switch.	EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
				MAINSTAGE OK NO. 1 DEPRESSURIZED light on.
				MAINSTAGE OK NO. 1 PRESSURIZED light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 28 of 43)

Step	Loc	Operation	Loc	Result
				MAINSTAGE OK NO. 2 PRESSURIZED light off.
			GR	CUTOFF light on.
			ETM	IGNITION PHASE CONTROL light off.
				MAINSTAGE CONTROL light off.
				IGNITION COMPLETE light off.
				MAINSTAGE OK light off.
				HELIUM CONTROL light off after approximately one second.
			S	IGN. PHASE SOL. ENERGIZED light off.
				MAINSTAGE SOL. ENERGIZED light off.
				HELIUM SOL. ENERGIZED light off after approximately one second.
				6, 19, 32, 39, and 40 lights on.
				5, 12, 14, 18, 29, 30, and 31 lights off.
				4 light off after approximately one second.
160	IF	Check continuity between J10-R and J10-S.	TE	No continuity.
161	S	Move MAINSTAGE OK PRESSURE SW NO. 1 to OPEN.	EC	MAINSTAGE OK NO. 1 DEPRESSURIZED light flickers as switch is actuated.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 29 of 43)

Step	Loc	Operation	Loc	Result
162	S	Move MAINSTAGE OK PRESSURE SW NO. 2 to CLOSED.	EC	MAINSTAGE OK NO. 2 DEPRESSURIZED light flickers as switch is actuated.
163	1F	Check continuity between J10-G and J10-J.	TE	Continuity.
164	EC	Momentarily depress CUTOFF RESET.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			ETM	IGNITION COMPLETE light on.
			S	29 light on.
				6, 39, and 40 lights off.
165	EC	Momentarily depress ENGINE START switch.	EC	MAINSTAGE OK NO. 2 PRESSURIZED light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light off.
			ETM	IGNITION PHASE CONTROL light on.
				HELIUM CONTROL light on.
				START TANK DISCH. CONTROL light on momentarily.
				MAINSTAGE OK light on.
				MAINSTAGE CONTROL light on.
			S	HELIUM SOL. ENERGIZED light on.
				IGN. PHASE SOL. ENERGIZED light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 30 of 43)

Step	Loc	Operation	Loc	Result
				START TANK DISCH. SOL. ENERGIZED light on momentarily.
				MAINSTAGE SOL. ENERGIZED light on.
				4, 5, 12, 14, 18, and 31 lights on.
				3, 7, and 9 lights on momentarily.
				19 and 33 lights off.
166	IF	Check continuity between J10-J and J10-K.	TE	Continuity.
167	IF	Check continuity between J10-G and J10-J.	TE	No continuity.
168	EC	Momentarily depress CUTOFF switch.	EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light on.
				MAINSTAGE OK NO. 2 PRESSURIZED light off.
			GR	CUTOFF light on.
			ETM	IGNITION PHASE CONTROL light off.
				MAINSTAGE CONTROL light off.
				IGNITION COMPLETE light off.
				HELIUM CONTROL light off after one second.
			S	IGN. PHASE SOL. ENERGIZED light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 31 of 43)

Step	Loc	Operation	Loc	Result
				MAINSTAGE SOL. ENERGIZED light off.
				HELIUM SOL. ENERGIZED light off after one second.
				6, 19, 33, 39, and 40 lights on.
				5, 12, 14, 18, 29, and 31 lights off.
				4 light off after approximately one second.
169	IF	Check continuity between J10-J and J10-K.	TE	No continuity.
170	ETM	Move IGNITION COMPLETE switch to OFF.		No visible results.
171	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			S	6, 39, and 40 lights off.
172	ETM	Move switch immediately below IGNITION BUS ARMED light to ARMED.	ETM	IGNITION BUS ARMED light comes on.
			EC	ENGINE BUS VOLTAGE indicates 24-30 vdc.
173	EC	Momentarily depress ENGINE START switch.	EC	MAINSTAGE OK NO. 2 PRESSURIZED light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light off.
			ETM	HELIUM CONTROL light on.
				IGNITION PHASE CONTROL light on.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 32 of 43)

Step	Loc	Operation	Loc	Result
				START TANK DISCH. CONTROL light on momentarily.
				NO. 1 ASI SPARK light on and off.
				NO. 2 ASI SPARK light on and off.
				NO. 1 GG SPARK light on and off.
				NO. 2 GG SPARK light on and off.
				IGNITION COMPLETE light on.
				MAINSTAGE CONTROL light on.
				MAINSTAGE OK light on.
			S	HELIUM SOL. ENERGIZED light on.
				IGN. PHASE SOL. ENERGIZED light on.
				START TANK DISCH. SOL. ENERGIZED light on momentarily.
				MAINSTAGE SOL. ENERGIZED light on.
				3, 7, and 9 lights on momentarily.
				4, 5, 12, 14, 18, 29, and 31 lights on.
				23, 24, 25, and 26 lights on and off.
				19 and 33 lights off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 33 of 43)

Step	Loc	Operation	Loc	Result
174	EC	Momentarily depress CUTOFF switch.	EC	CUTOFF light on.
				CUTOFF LOCKIN light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light on.
				MAINSTAGE OK NO. 2 PRESSURIZED light off.
			GR	CUTOFF light on.
			ETM	IGNITION PHASE CONTROL light off.
				MAINSTAGE CONTROL light off.
				IGNITION COMPLETE light off.
				MAINSTAGE OK light off.
				HELIUM CONTROL light off after approximately one second.
			S	IGN. PHASE SOL. ENERGIZED light off.
				MAINSTAGE SOL. ENERGIZED light off.
				HELIUM SOL. ENERGIZED light off after approximately one second.
				6, 19, 33, 39, and 40 lights on.
				5, 12, 14, 18, 29, and 31 lights off.
				4 light off after approximately one second.
175	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF light off.
				CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			S	6, 39, and 40 lights off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 34 of 43)

Step	Loc	Operation	Loc	Result
176 through 180 (Deleted)				
181		Disconnect oscilloscope leads from terminal boards.		No visible results.
182	GR	Move TEST/FIRE SELECT switch to AREA CLEAR.	EC	AREA CLEAR light on. TEST light off.
			ETM	SEQUENCE TEST light off.
183	CTB	Install a jumper wire from TB2-11 to TB4-8.		No visible results.
184	IF	Apply 28 ±2 vdc (neg) to J239-N.		No visible results.
NOTE: In step 185, 28 vdc must be obtained from the console and remain applied.				
185	IF	Apply 28 ±2 vdc (pos) to J10-S.		No visible results.
186	S	Move START TANK switch to PRESSURIZED.	S	2 and 27 lights on. 28 light off.
			EC	ENGINE READY light on.
			ETM	START TANK PRESSURIZED light on. START TANK DEPRESSURIZED light off.
187	S	Move PREVALVES switch to OPEN.	EC	ARMED light on.
188 and 189 (Deleted)				
190	S	Move START TANK switch to DEPRESSURIZED.	S	28 light on. 2 and 27 lights off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 35 of 43)

Step	Loc	Operation	Loc	Result
			ETM	START TANK DEPRESSURIZED light on.
				START TANK PRESSURIZED light off.
			EC	ARMED light off.
				ENGINE READY light off.
191 (Deleted)				
192	IF	Check continuity between J10-J and J10-K.	TE	Continuity.
193	S	Move MAINSTAGE OK PRESS. SW NO. 1 to CLOSED.	EC	MAINSTAGE OK NO. 1 DEPRESSURIZED light flickers as switch is actuated.
194	S	Move START TANK switch to PRESSURIZED.	S	2 and 27 lights on.
				28 light off.
			EC	ARMED light on.
				ENGINE READY light on.
			ETM	START TANK PRESSURIZED light on.
				START TANK DEPRESSURIZED light off.
NOTE: Conditions in step 195 occur when voltage is removed and revert when voltage is re-applied.				
195	IF	Momentarily remove 28 vdc (pos) from J10-S.	EC	ARMED light off.
				ENGINE READY light off.
			S	2 light off.
196	S	Move FUEL INJECTION TEMP switch to NOT SENSED.	ETM	FUEL INJECTION TEMPERATURE OK light off.
			S	1 light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 36 of 43)

Step	Loc	Operation	Loc	Result
197	EC	Move ARMED TEMP DETECT BYPASS switch up.		No visible results.
198	DR	Prepare the data recorder to record timing required by step 199 by energizing the event recorder and setting chart speed at NO. 125. After completion of step, deenergize event recorder.		

NOTE: There is no requirement in step 199 to verify condition of lights. Their condition (on or off) is directly related to the associated pen on the event recorder. See figure 4-17 for information on the interrelation of panel indicators. Lights without associated pens are listed, and their conditions noted, for reference purposes only.

199	EC	Momentarily depress ENGINE START switch.	DR	Event recorder indicates on and off cycling as shown in sequence B of figure 4-16.
			S	3 and 7 lights on momentarily when ENGINE START switch is depressed.
				HELIUM SOL. ENERGIZED light cycles with pen 4 of event recorder.
				IGN. PHASE SOL. ENERGIZED light cycles with pen 5 of event recorder.
				START TANK DISCH. SOL. ENERGIZED light cycles with pen 9 of event recorder.
				MAINSTAGE SOL. ENERGIZED light cycles with pen 12 of event recorder.
			EC	ARMED light cycles with pen 2 of event recorder.
200	S	Move SEQ CONT switch to CLOSED.		No visible results.
201	IF	Check continuity between J9-M and J9-N.	TE	Continuity.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 37 of 43)

Step	Loc	Operation	Loc	Result
202	S	Move OBSERVER CUT-OFF switch to CUTOFF.	S	IGN. PHASE SOL. ENERGIZED light off.
				MAINSTAGE SOL. ENERGIZED light off.
				2, 6, 19, 27, 32, 33, 36, and 40 lights on.
				4, 5, 12, 14, 18, 28, 29, 30, and 31 lights off.
				39 light on momentarily.
				HELIUM SOL. ENERGIZED light off after one second.
			GR	CUTOFF light on.
			EC	CUTOFF light on momentarily.
				CUTOFF LOCKIN light on.
				MAINSTAGE OK NO. 1 DEPRESSURIZED light on.
				MAINSTAGE OK NO. 2 DEPRESSURIZED light on.
				ENGINE READY light on.
				ARMED light on.
				MAINSTAGE OK NO. 1 PRESSURIZED light off.
				MAINSTAGE OK NO. 2 PRESSURIZED light off.
			ETM	START TANK PRESSURIZED light on.
				START TANK DEPRESSURIZED light off.
				IGNITION PHASE CONTROL light off.
				MAINSTAGE CONTROL light off.
				IGNITION COMPLETE light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 38 of 43)

Step	Loc	Operation	Loc	Result
				MAINSTAGE OK light off.
				HELIUM CONTROL light off after one second.
203	S	Move OBSERVER CUTOFF switch to OFF.	S	36 light off.
204	EC	Momentarily depress CUTOFF RESET switch.	EC	CUTOFF LOCKIN light off.
			GR	CUTOFF light off.
			S	6 and 40 lights off.
205	S	Move START TANK switch to DEPRESSURIZED.	S	28 light on.
				2 and 27 lights off.
			EC	ARMED light off.
				ENGINE READY light off.
206	IF	Remove jumper wire between TB2-11 and TB4-8.		No visible results.
207 (Deleted)				
208	S	Move START TANK switch to PRESSURIZED.	S	2 and 27 lights on.
				28 light off.
			EC	ARMED light on.
				ENGINE READY light on.
			ETM	START TANK PRESSURIZED light on.
				START TANK DEPRESSURIZED light off.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 39 of 43)

Step	Loc	Operation	Loc	Result
209	IF	Remove 28 vdc (pos) from J10-S.	EC	ARMED light off. ENGINE READY light off.
			S	2 light off.
210	IF	Apply 28 ±2 vdc (pos) to J239-P.	EC	ARMED light on. ENGINE READY light on.
			S	FLIGHT INST. DE-ENERGIZE light off. 2 light on.
211		Repeat step 199. There is no requirement to verify timing.		Same results as in step 199.
212	EC	Momentarily depress CUTOFF switch.		Same results as in step 202 except light 36 on SIMULATOR does not come on.
213	EC	Momentarily depress CUTOFF RESET switch.		Same results as in step 204.
214	IF	Remove 28 vdc from J239-N and J239-P.		Step 210 results reversed.
215		Remove jumper wire between TB4-15 on console terminal board and DS13-4 on rear of SIMULATOR.		No visible results.
216	PVPC	Depress circuit breaker.		No visible results.
217	PVPC	Move AC POWER switch up.	PVPC	AC POWER ON light on. VALVE OPENING meter indicates 60-70 percent.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 40 of 43)

Step	Loc	Operation	Loc	Result
NOTE: In steps 218 through 221, use multimeter to measure voltages.				
218	S	Measure voltage between right and left red jacks under 40 VAC 400 CYCLE.		50-70 vac.
219	S	Measure voltage between right red jack and black jack under 40 VAC 400 CYCLE.	TE	25-35 vac.
220	S	Measure voltage between 115 VAC 400 CYCLE jacks (black is common).	TE	60-80 vac.
NOTE: Record voltage obtained in step 220. Comparison is made between this voltage and that obtained in step 221.				
221	S	Measure voltage between 115 VAC 400 CYCLE red jack and chassis ground.	TE	Within 0.5 vac of voltage obtained in step 220.
222	PVPC	Move NOMINAL VALVE OPENING switch to NOMINAL VALVE OPENING.	PVPC	VALVE OPENING meter indicates 30-40 percent.
223	PVPC	Move NOMINAL VALVE OPENING switch to VALVE OPENING.	PVPC	VALVE OPENING meter indicates 60-70 percent.
224	PVPC	Move AC POWER switch to OFF.	PVPC	AC POWER ON light off. VALVE OPENING meter indicates zero.
CAUTION: In step 225, oscillograph ground or common lead must not be connected to 40 VAC jacks or to 115 VAC red jack, since damage to amplifier can result.				
225	S	Connect oscilloscope as follows: a. Under 40 VAC 400 CYCLE, connect input A to left red jack and input B to right red jack.		No visible results.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 41 of 43)

Step	Loc	Operation	Loc	Results
		b. Under 115 VAC 400 CYCLE, connect SCOPE GROUND to black jack and EXTERNAL SWEEP IN to red jack.		
226		Adjust oscilloscope as follows: a. INPUT SELECTOR to AC A-B. b. MV/CM to 1,000. c. MV/CM multiplier to 50. d. HORIZONTAL SLOPE to (-). e. ATTENUATION to X10. f. EXTERNAL SWEEP ATTENUATION to minimum (counterclockwise). g. HORIZONTAL DISPLAY to external sweep. h. TIME/CM to one millisecond. i. 5X magnifier to OFF.		No visible results.
227	PVPC	Move AC POWER switch up.	PVPC	AC POWER ON light on. VALVE OPENING meter indicates 60-70 percent. Signal pattern on oscilloscope is 180 degrees out-of-phase.
228	PVPC	Rotate VALVE POSITION INPUT REFERENCE potentiometer clockwise until signal pattern on oscilloscope passes through zero to an in-phase pattern.		Signal pattern will pass through zero to an in-phase pattern when VALVE POSITION INPUT REFERENCE indicates 600-700 dial units.

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 42 of 43)

Step	Loc	Operation	Loc	Result
229	PVPC	Move AC POWER switch to OFF.	PVPC	AC POWER ON light off.
230		Turn off oscilloscope and disconnect leads.		No visible results.
231		Return all switches to OFF or down position.		
232		Pull out all circuit breakers.		
233		Deenergize facility power to console.		
234	IF	Disconnect test cables and install protective dust caps on electrical connectors.		

Figure 4-15. Function-Testing Electrical Checkout Console (Sheet 43 of 43)

Pages 4-63 through 4-66 deleted.

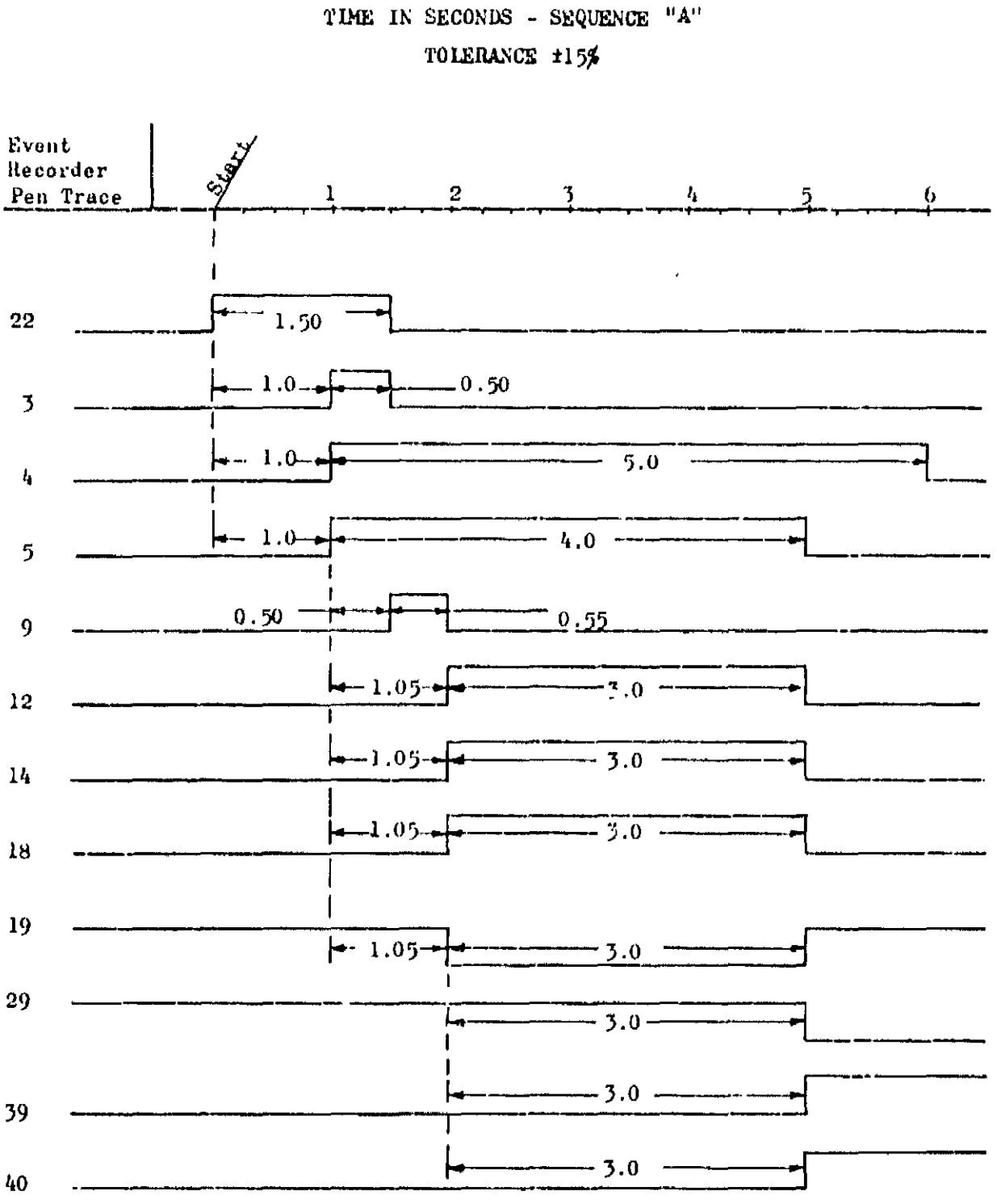


Figure 4-16. Timing Check (Sheet 1 of 2)

TIME IN SECONDS - SEQUENCE "B"

TOLERANCE ±15% UNLESS NOTED OTHERWISE

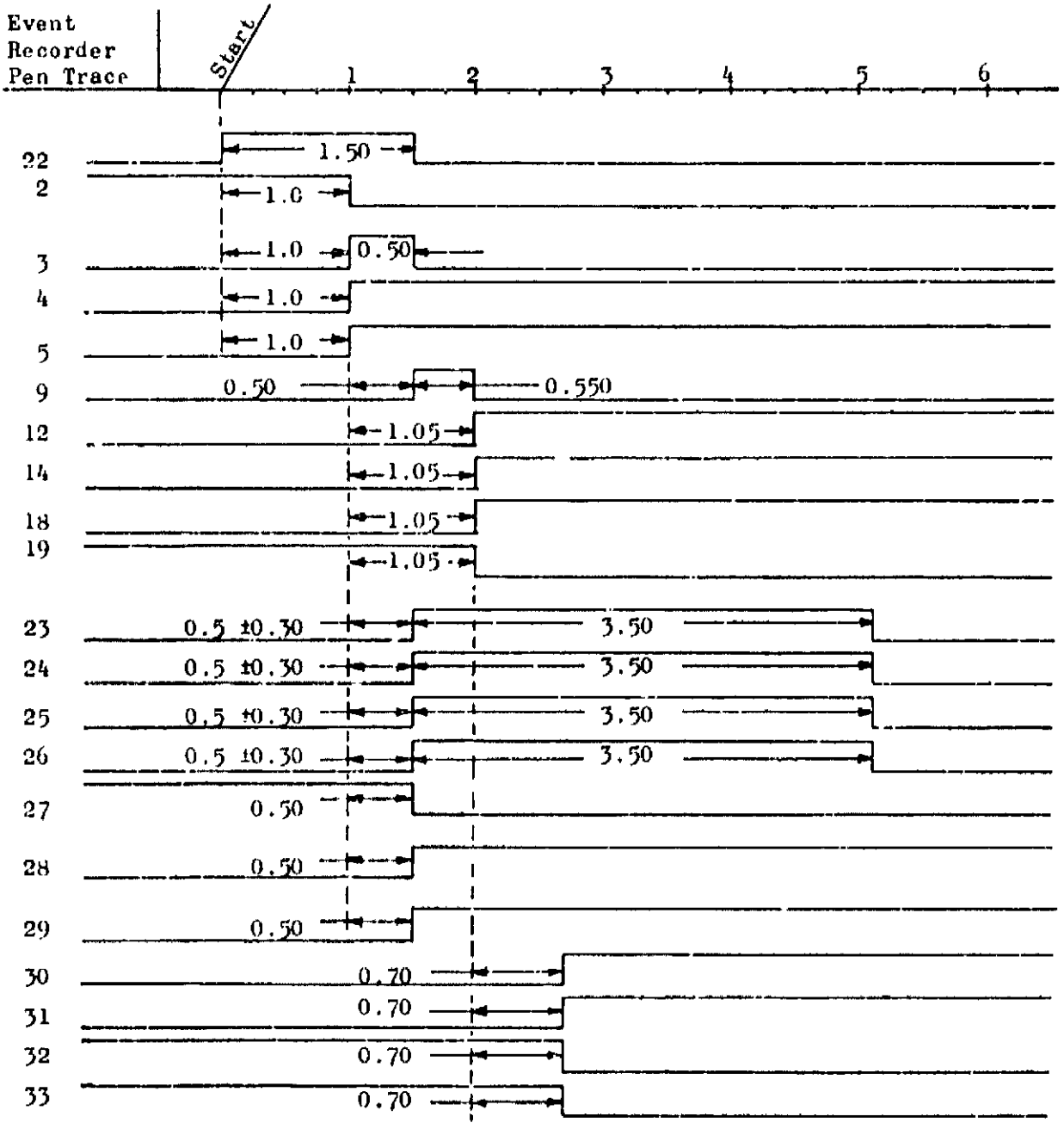


Figure 4-16. Timing Check (Sheet 2 of 2)

Pen Light Number	Recorder Pen Number	Location	Nomenclature
1	1	ETM	FUEL INJECTION TEMPERATURE OK
2	2	EC	ENGINE READY
3	3		On momentarily when ENGINE START switch is actuated.
4	4	ETM	HELIUM CONTROL
5	5	ETM	IGNITION PHASE CONTROL
6	None	EC	CUTOFF LOCKIN
7	None		On momentarily when ENGINE START switch is actuated.
8	None	EC	On when ENGINE POWER circuit breaker is actuated.
9	9	ETM	START TANK DISCH. CONTROL
10	None		None
11	None		None
12	12	ETM	MAINSTAGE CONTROL
13	None		None
14	14	ETM	MAINSTAGE INITIATED (a)
15	None		None
16	None		None

ETM Engine test monitor panel.
EC Engine control panel.
(a) On consoles not incorporating MD14 change.

Figure 4-17. Interrelation of Panel Lights (Sheet 1 of 3)

Pen Light Number	Recorder Pen Number	Location	Nomenclature
17	None		None
18	18	ETM	MAINSTAGE CONTROL
19	19		On when MAINSTAGE CONTROL goes off.
20	None		None
21	None		None
22	None		None
23	23	ETM	NO. 1 ASI SPARK
24	24	ETM	NO. 2 ASI SPARK
25	25	ETM	NO. 1 GG SPARK
26	26	ETM	NO. 2 GG SPARK
27	27	ETM	START TANK PRESSURIZED
28	28	ETM	START TANK DEPRES-SURIZED
29	29	ETM	IGNITION COMPLETED
30	30	ETM	MAINSTAGE OK
		EC	MAINSTAGE OK NO. 1 PRESSURIZED
31	31	ETM	MAINSTAGE
		EC	MAINSTAGE OK NO. 2 PRESSURIZED
32	32	EC	MAINSTAGE OK NO. 1 DEPRESSURIZED

ETM Engine test monitor panel.
EC Engine control panel.

Figure 4-17. Interrelation of Panel Lights (Sheet 2 of 3)

Pen Light Number	Recorder Pen Number	Location	Nomenclature
33	33	EC	MAINSTAGE OK NO. 2 DEPRESSURIZED
34	None		None
35	None		None
36	36		On when OBSERVER CUTOFF switch is energized.
37	None		None
38	None		None
39	39	EC	CUTOFF
40	40	EC	CUTOFF LOCKIN

EC Engine control panel.

Figure 4-17. Interrelation of Panel Lights (Sheet 3 of 3)

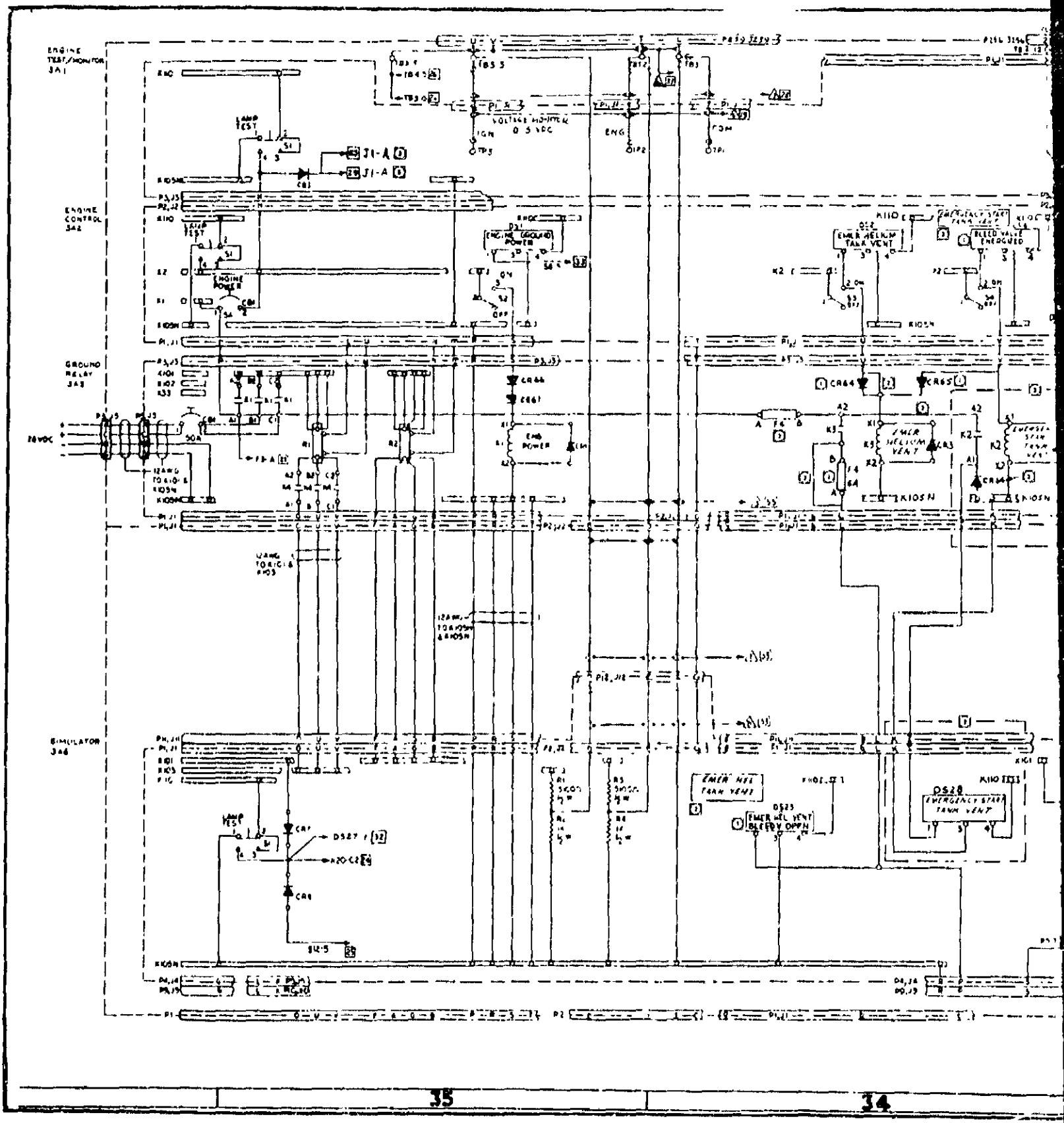
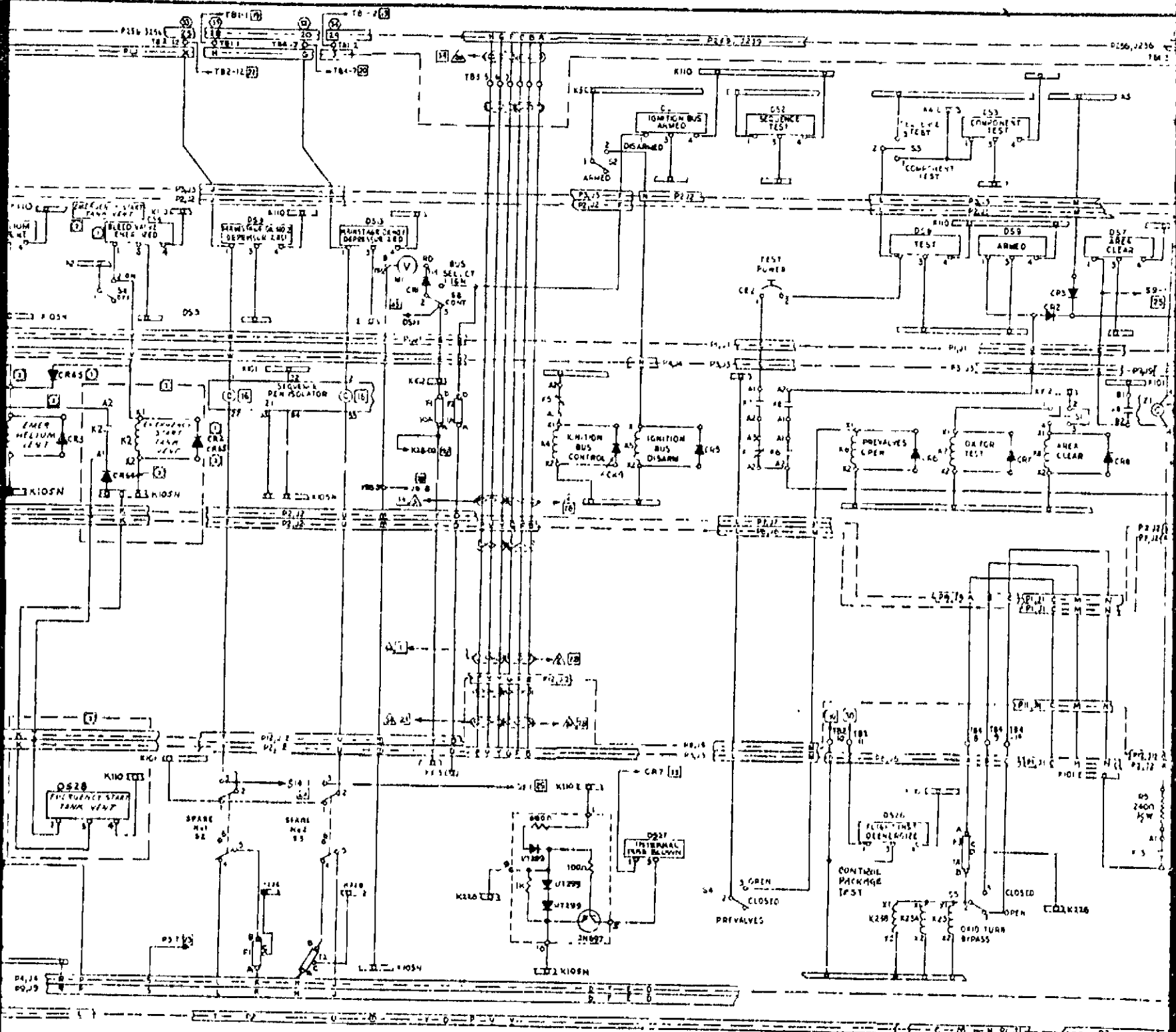


Figure 4-18. Electrical Schematic (Sheet 1 of 4)



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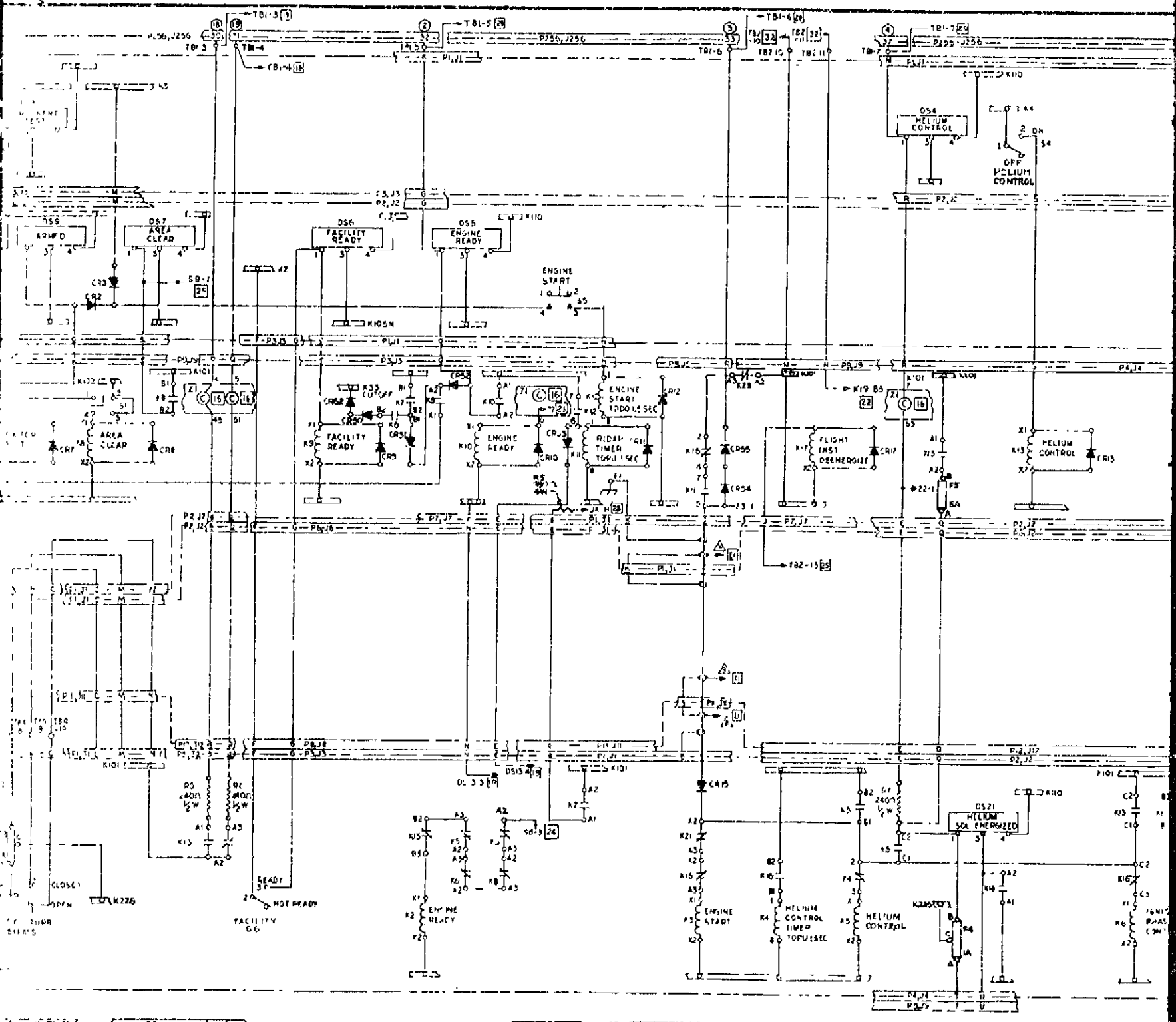
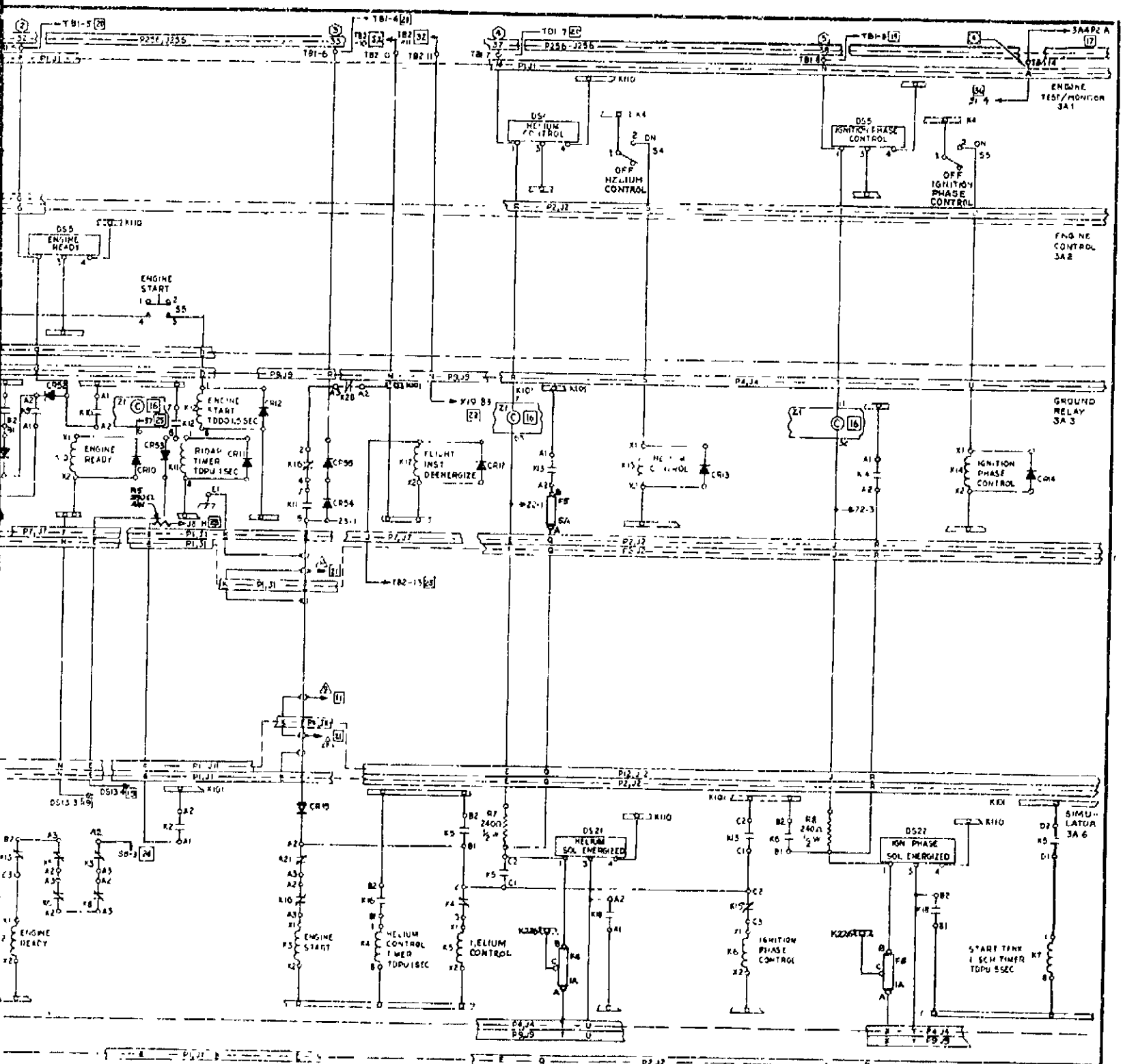
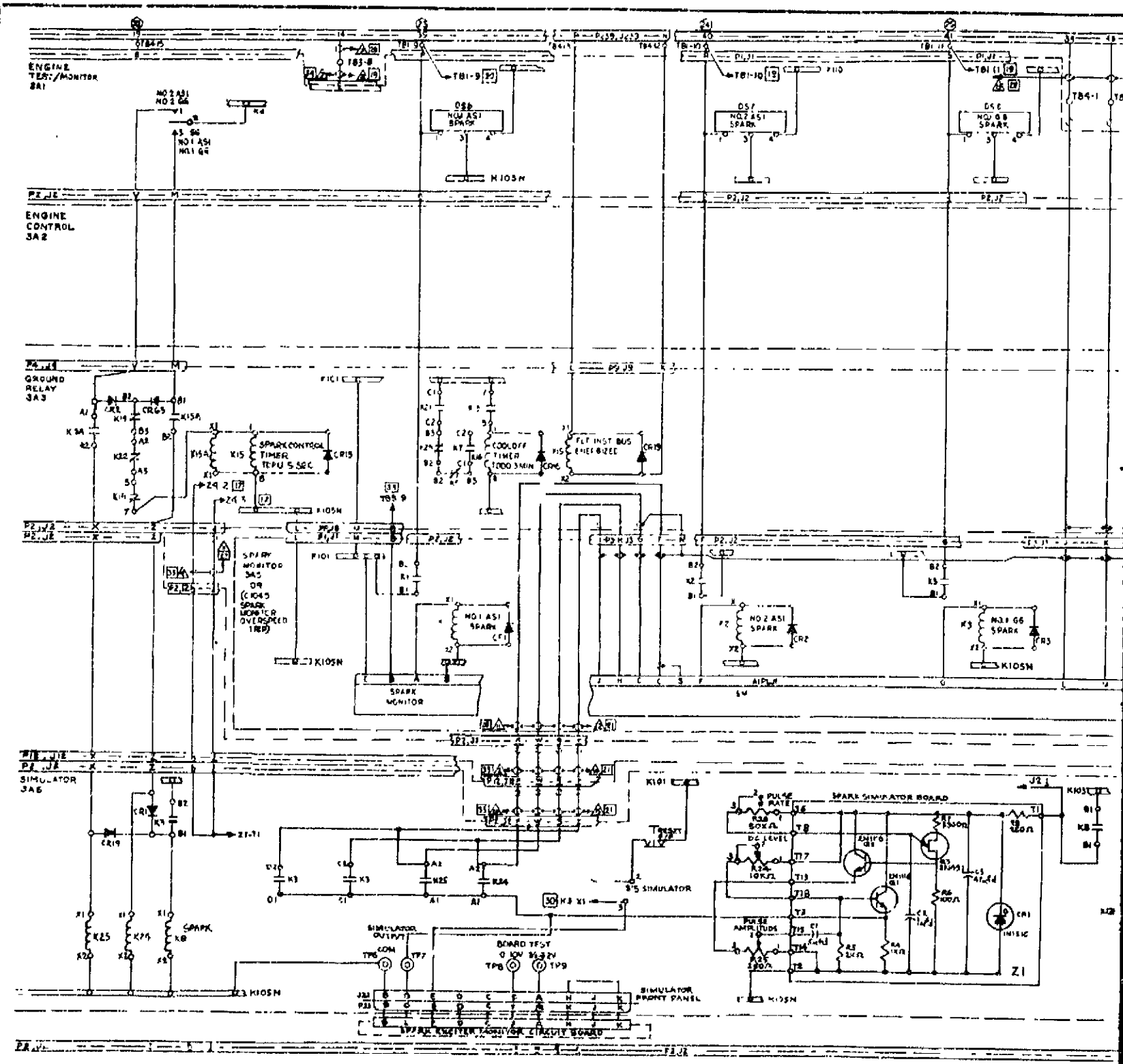


1 LETED ON CONSOLES INCORPORATING MD15 CHANGE
ADDED ON CONSOLES INCORPORATING MD15 CHANGE
ON CONSOLES INCORPORATING MD16 CHANGE

[2] NO CONNECTION BETWEEN 3A1P1-A AND TB4-14 ON CONSOLES INCORPORATING MD16 CHANGE
[3] ON CONSOLES NOT INCORPORATING MD16 CHANGE



[4] NO CONNECTION BETWEEN 3A1P1-A AND TB4-14 ON CONSOLES INCORPORATING MD16 CHANGE
[5] ON CONSOLES NOT INCORPORATING MD16 CHANGE


ENGINE TEST/MONITOR 8A1
ENGINE CONTROL 3A2
GROUND RELAY 3A3
SIMULATOR 3A6
SPARK CONTROL TIMER TEPU 5 SEC
COOL OFF TIMER 1000 SMIN
FLT INST BUS ENERGIZED
SPARK MONITOR 3A5
SPARK MONITOR
SPARK SIMULATOR BOARD
SIMULATOR FRONT PANEL
BOARD TEST
SIMULATOR OUTPUT
NO 1 ASI SPARK
NO 2 ASI SPARK
NO 3 G6 SPARK
NO 4 G8 SPARK
K105N
K103N
K101
K103
K25
K26
K8
CR15
CR16
CR19
CR1
CR2
CR3
Z1-T1
Z2-T2
Z3-T3
Z4-T4
Z5-T5
Z6-T6
Z7-T7
Z8-T8
Z9-T9
Z10-T10
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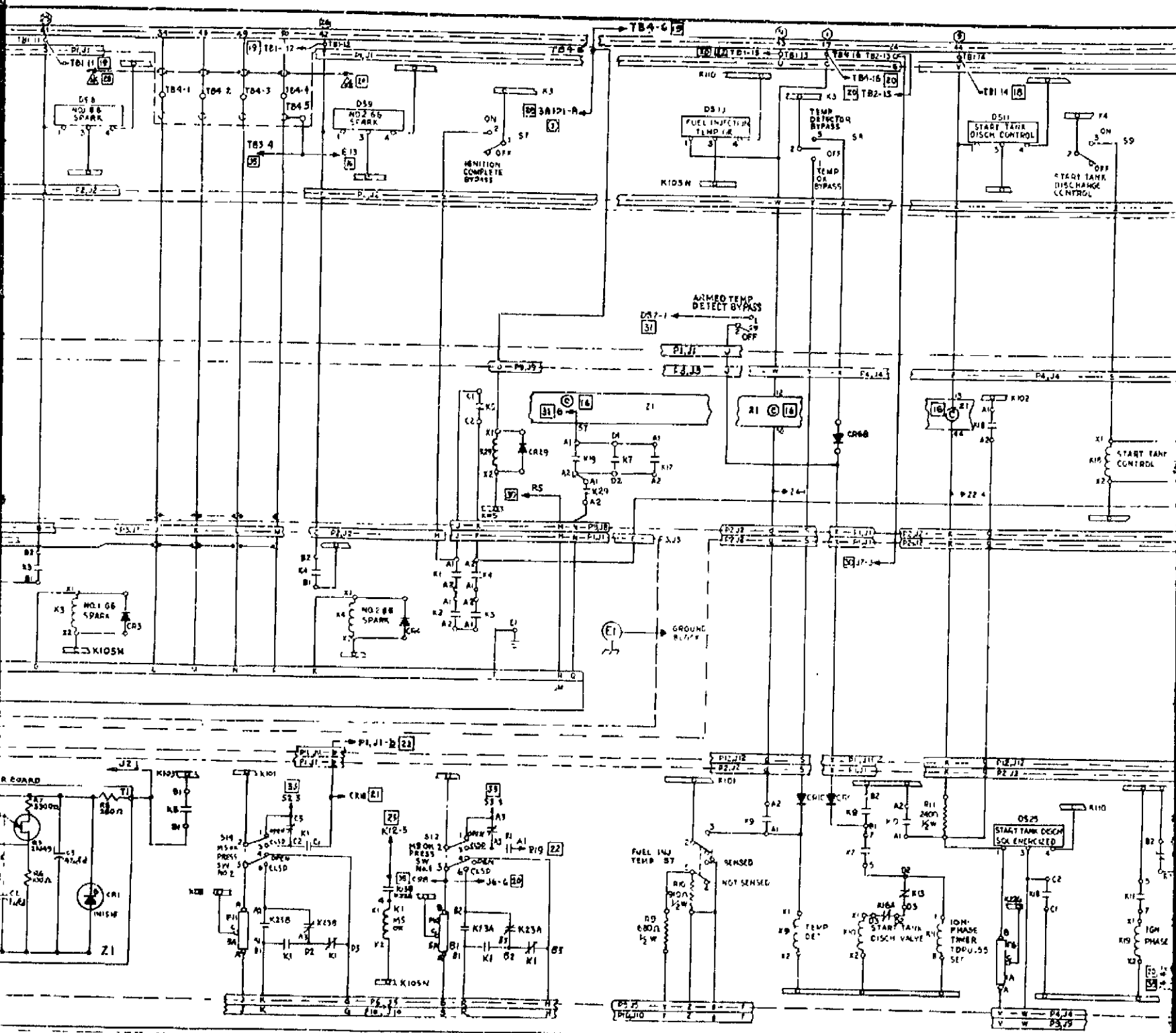
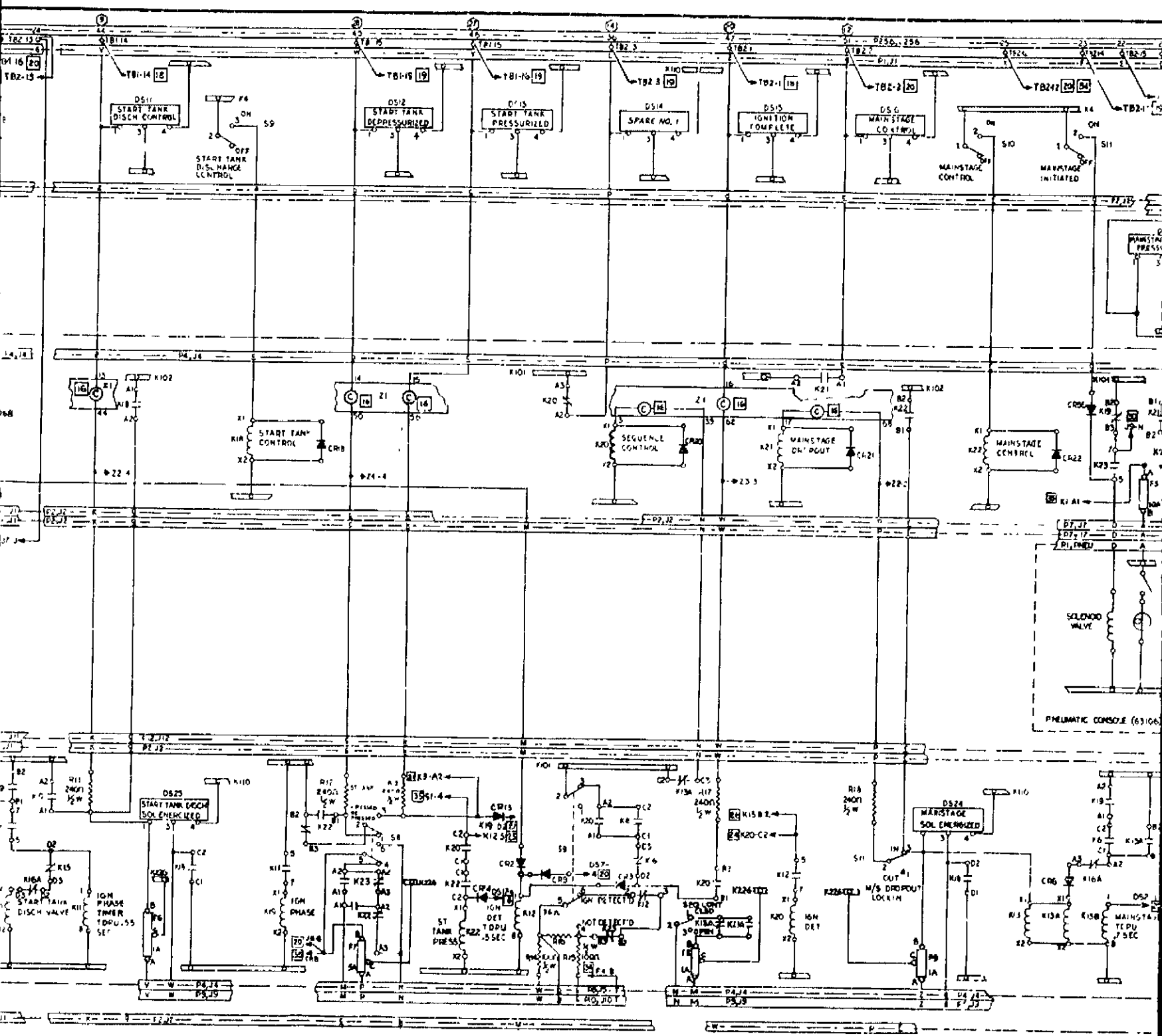
Z67-T67
Z68-T68
Z69-T69
Z70-T70
Z71-T71
Z72-T72
Z73-T73
Z74-T74
Z75-T75
Z76-T76
Z77-T77
Z78-T78
Z79-T79
Z80-T80
Z81-T81
Z82-T82
Z83-T83
Z84-T84
Z85-T85
Z86-T86
Z87-T87
Z88-T88
Z89-T89
Z90-T90
Z91-T91
Z92-T92
Z93-T93
Z94-T94
Z95-T95
Z96-T96
Z97-T97
Z98-T98
Z99-T99
Z100-T100

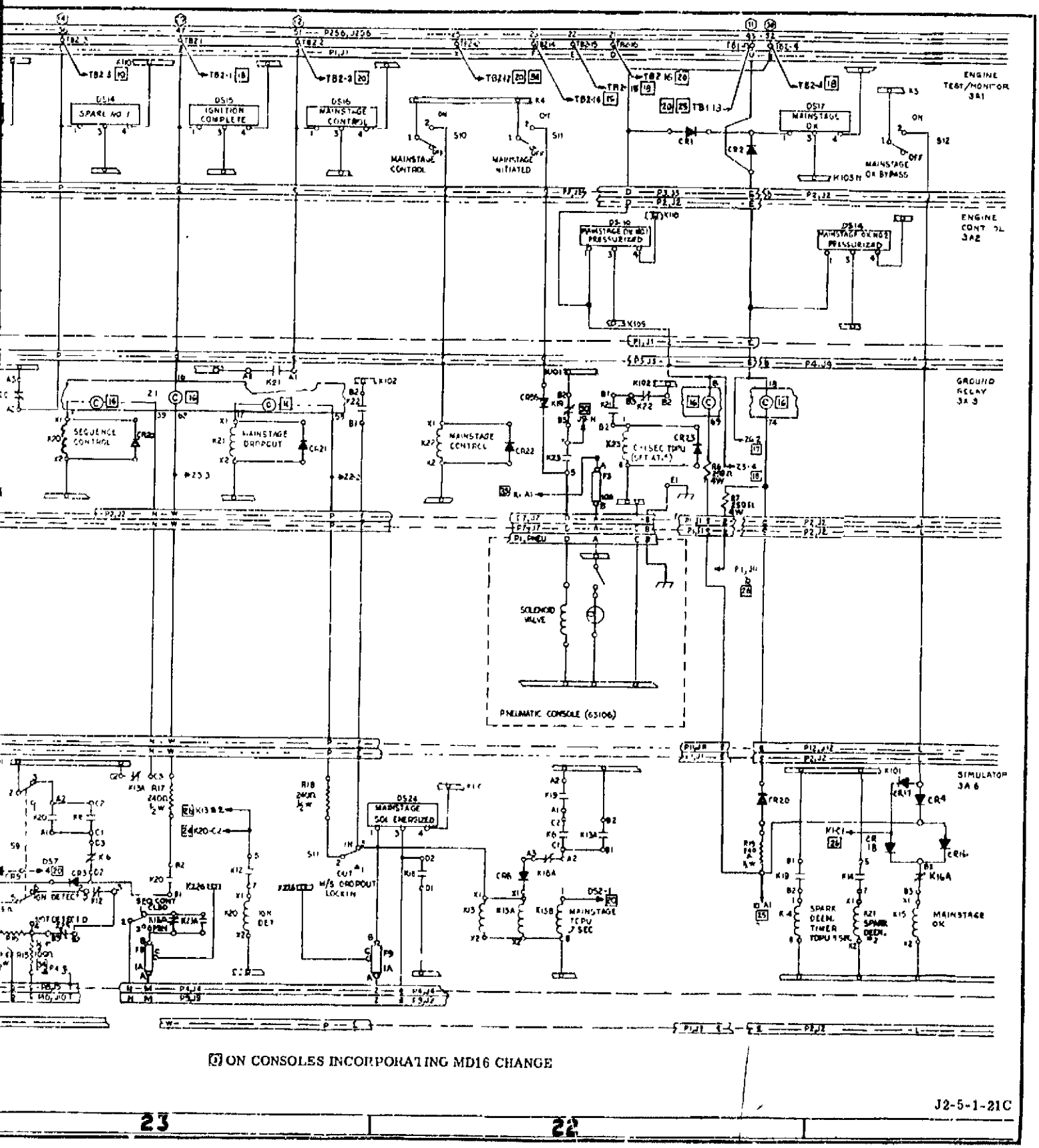

TB4-6
TB4-1
TB4-2
TB4-3
TB4-4
TB4-5
TB3-4
DS8 NO 66 SPARK
DS9 NO 2 66 SPARK
IGNITION COMPLETE BY 2455
3B121-A
DS10 FUEL INJECTION TEMP (R
TEMP DETECTOR BYPASS
TEMP OR BYPASS
K10SN
DS11 START TANK DISCH CONTROL
START TANK DISCHARGE CONTROL
ARMED TEMP DETECT BYPASS
DS7-1
RS
CR69
START TANK CONTROL
NO 1 66 SPARK
NO 2 66 SPARK
GROUND BUSS
K10SN
FUEL INJ TEMP ST
SENSED
NOT SENSED
TEMP DET
START TANK DISCH VALVE
IGN PHASE TIMER TDPU-55 SEC
DS25 START TANK DISCH SOL ENERGIZED
IGN PHASE
Z1
R9 680Ω ½ W
R11 2400Ω ½ W
R10 390Ω ½ W



[3] ON CONSOLES INCORPORATING MD16 CHANGE

24 23 22

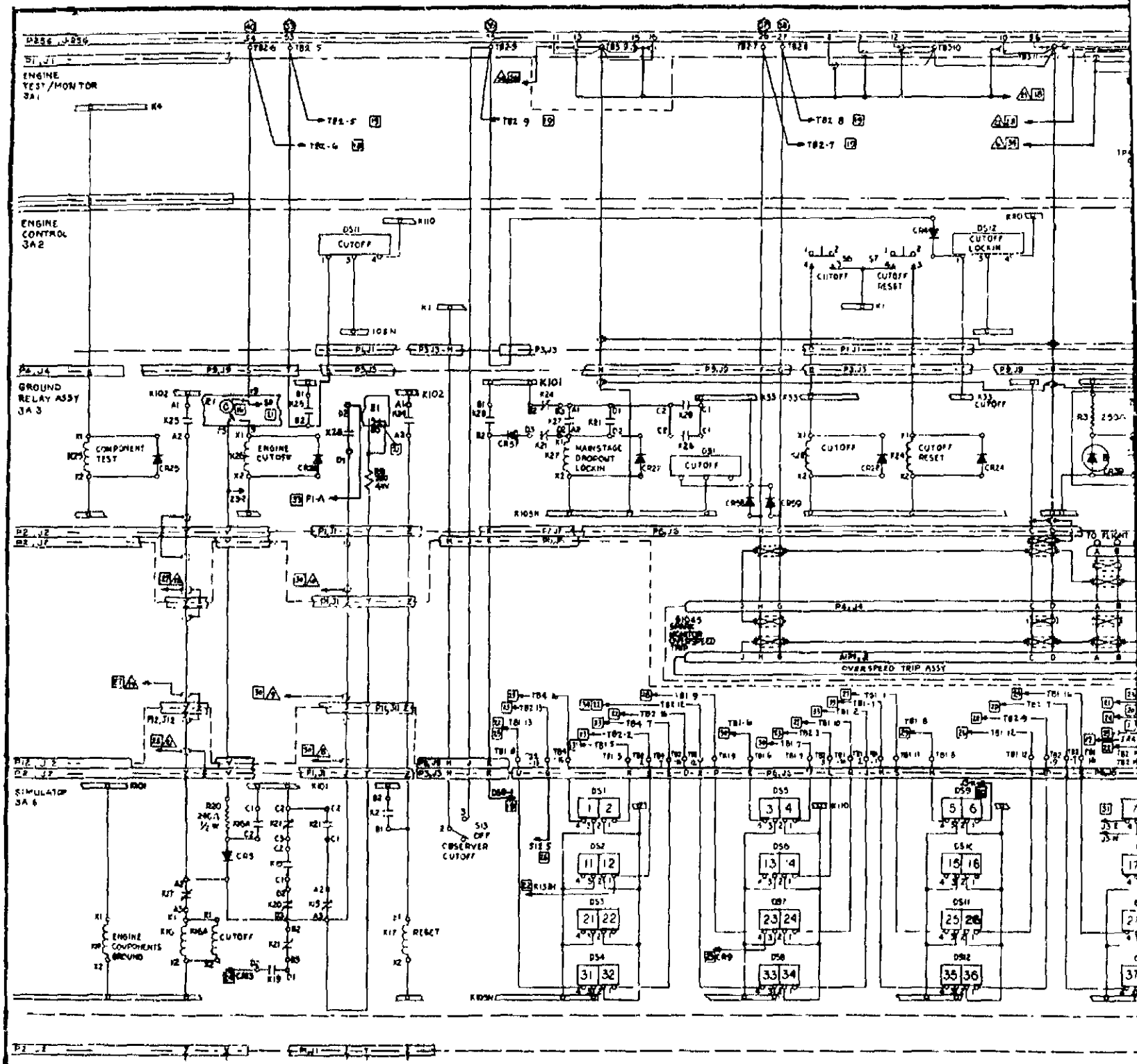
Figure 4-18. Electrical S



[7] ON CONSOLES INCORPORATING MD16 CHANGE

J2-5-1-21C

Figure 4-18. Electrical Schematic (Sheet 2 of 4)



[3] ON CONSOLES INCORPORATING MD16 CHANGE

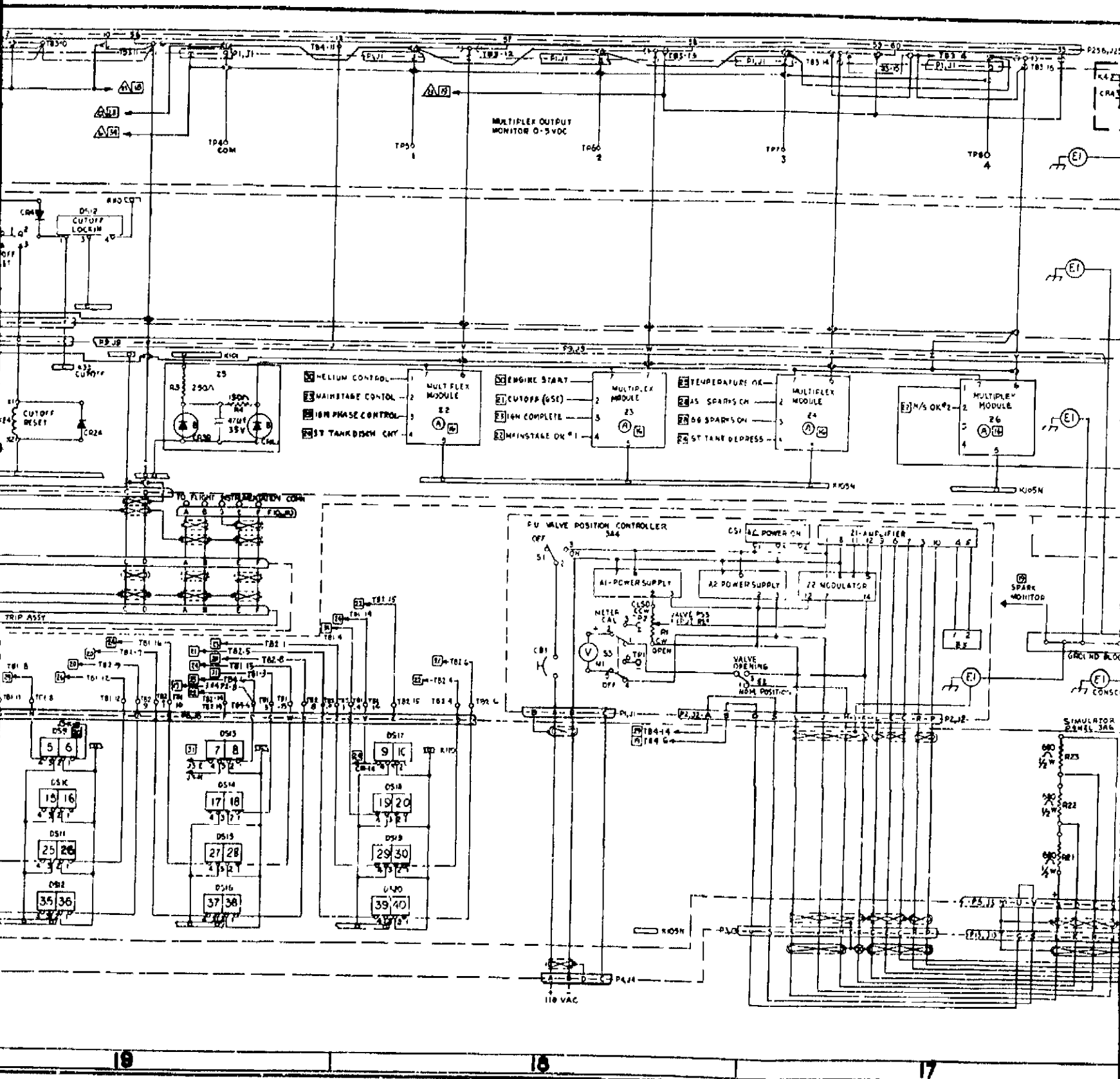

MULTIPLEX OUTPUT MONITOR 0-5 VDC
TP40 COM
TP50 1
TP60 2
TP70 3
TP80 4
CUTOFF LOCKIN
CUTOFF RESET
CR24
HELIUM CONTROL
MAINSTAGE CONTROL
IGN PHASE CONTROL
ST TANK DISCH CNT
MULT FLEX MODULE
A2
ENGINE START
CUTOFF (GSE)
IGN COMPLETE
MAINSTAGE OK #1
MULTIPLEX MODULE
A3
TEMPERATURE OK
AS SPARKS ON
BS SPARKS ON
ST TANK DEPRESS
MULTIPLEX MODULE
A4
N/S OK #2
MULTIPLEX MODULE
A6
TO FLIGHT INSTRUMENTATION CONN
TRIP ASSY
FU VALVE POSITION CONTROLLER
SA4
A1 POWER SUPPLY
A2 POWER SUPPLY
Z2 MODULATOR
Z1 AMPLIFIER
A/C POWER ON
SPARK MONITOR
METER CAL
VALVE OPENING
NORM POSITION
110 VAC
SIMULATOR
SA6
R23
R22
R21

Figure 4-18.

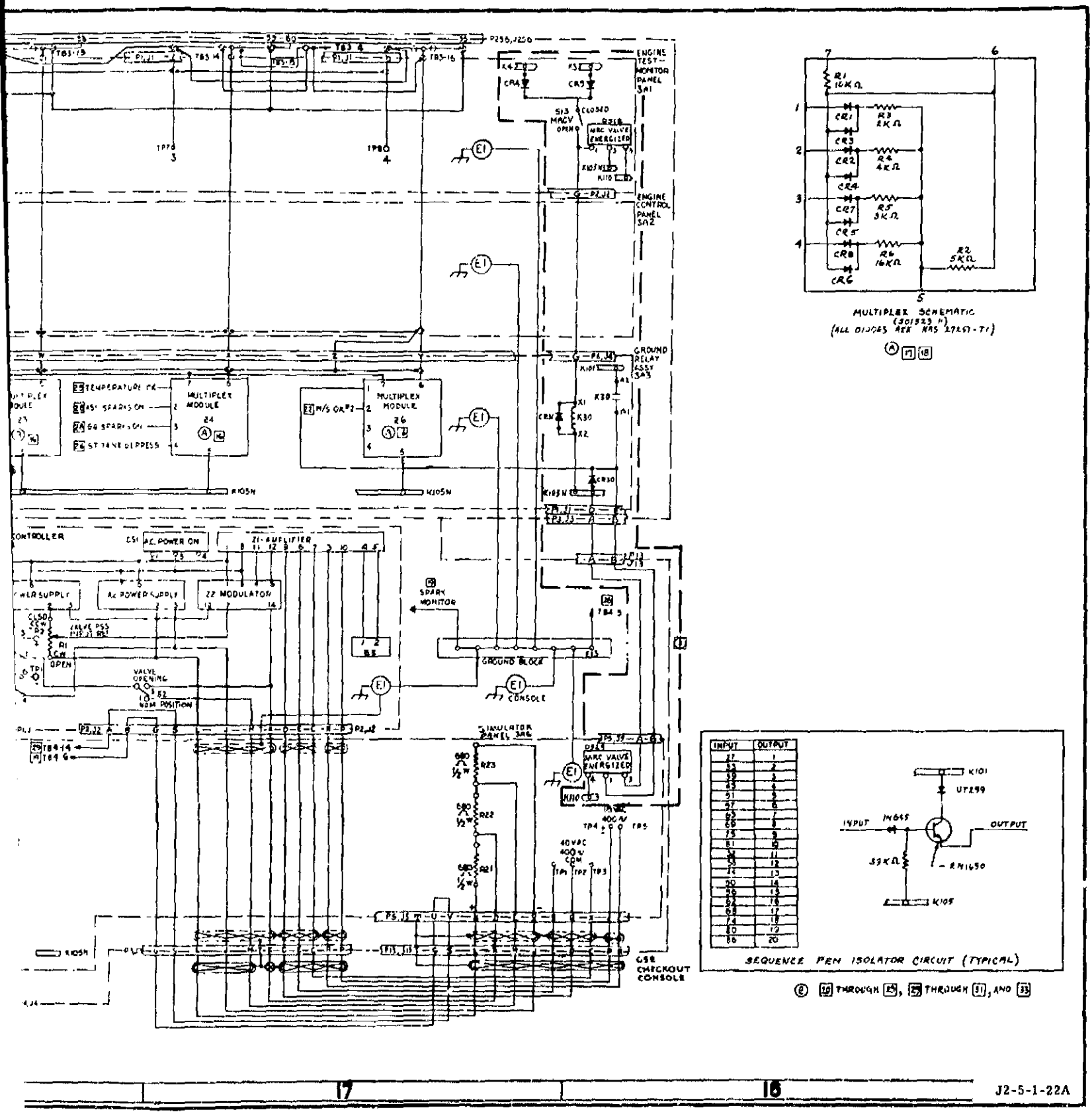


Figure 4-18. Electrical Schematic (Sheet 3 of 4)

Unit	Code	Zone		
		Coil	Contacts	
			Normally Open	Normally Closed
Ground Relay Panel	K1	35	35, 35, 35	---
	K2	34	34	---
	K3	34	34	---
	K4	33	35, 35, 35	---
	K5	32	26	33, 28
	K6	32	31, 32	32
	K7	32	25, 28, 31 32	---
	K8	32	31, 32	---
	K9	31	31	---
	K10	31	31	---
	K11	30	30	---
	K12	30	30	---
	K13	29	30	---
	K14	29	29	28
	K15	28	28	---
	K15A	28	28, 28	---
	K16	28	---	30, 28
	K17	30	25	---
	K18	24	24	---
	K19	27	25	22
	K20	23	---	23
	K21	23	20, 22, 23, 28	20
	K22	22	23	22, 28
	K23	22	22	---
	K24	19	20	20
	K25	21	21	28
	K26	21	20, 21	---
	K27	20	20	---
	K28	20	20, 20, 21	30
	K29	25	25	---
	K30	16	16	---
Simulator Panel	K1	26	25, 25, 26, 26	25, 25 26, 26
	K2	31	20, 30	---
	K3	30	28, 28, 28	31
	K4	30	---	30
	K5	30	29, 30, 30	31
	K6	29	22, 29	31
	K7	29	25	
	K8	28	23, 26	31
	K9	25	25, 25	---
	K10	25	25	---
	K11	24	24	---
	K12	23	23	23
	K13	22	29, 31	25, 31, 31
	K13A	22	22	23, 23
	K13B	22	26	---
	K14	22	21	---
	K15	21	---	21
	K16	21	30	23, 29, 30
	K16A	21	21	21, 22, 25
	K17	20	---	21
	K18	21	22, 24, 29, 29	---
	K19	24	21, 21, 22, 22	---
	K20	23	23, 23, 24	21
	K21	21	21	21, 21, 30
	K22	24	24, 24, 24	24, 24
	K23	32	24	23, 24
	K23A	32	23, 26	25
	K23B	32	26	26
	K24	28	28	---
	K25	28	28	---
Spark Monitor Panel	K1	28	28, 26	---
	K2	27	27, 26	---
	K3	26	26, 26	
	K4	26	26, 26	

Figure 4-18. Electrical Schematic (Sheet 4 of 4)

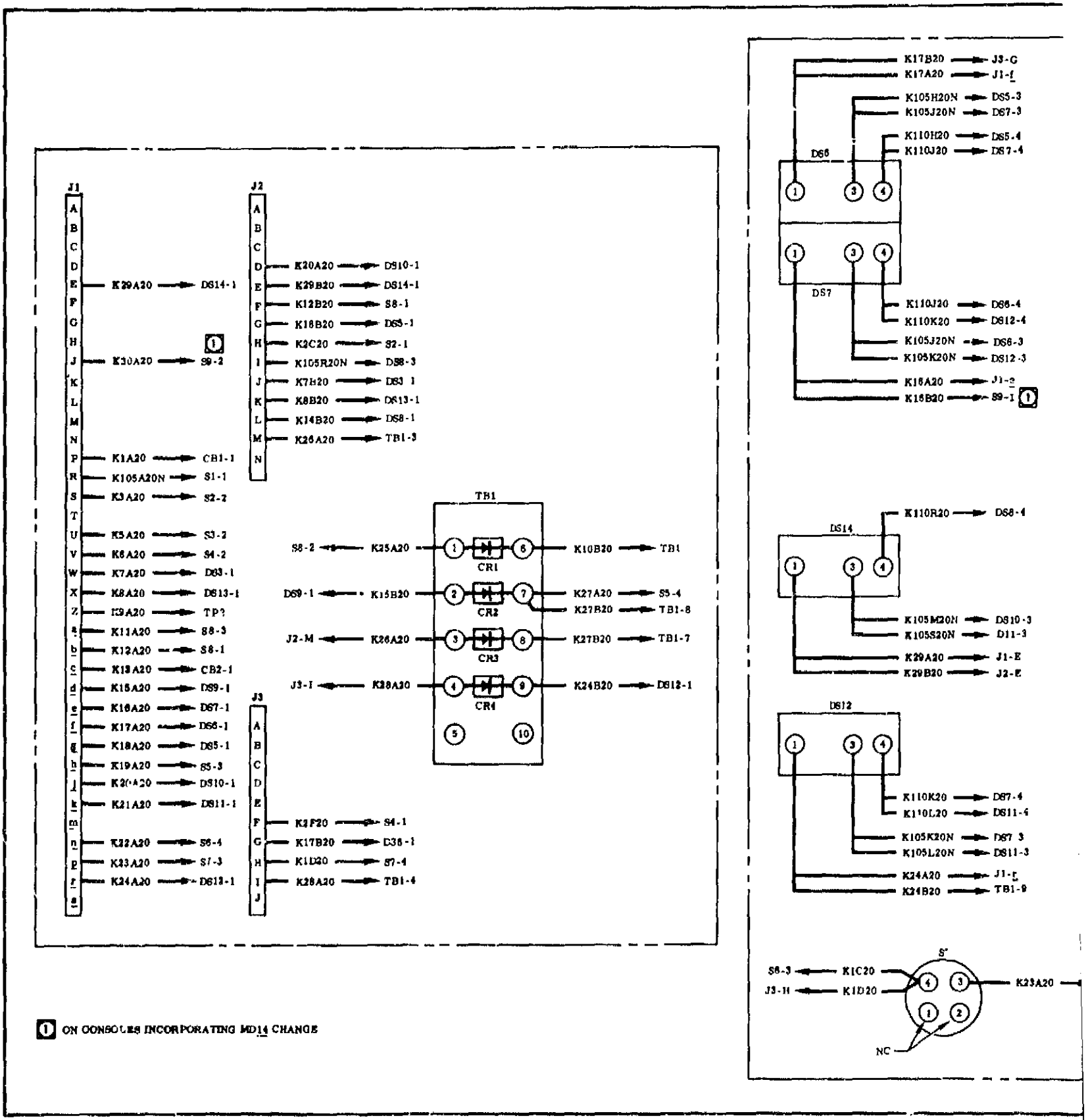
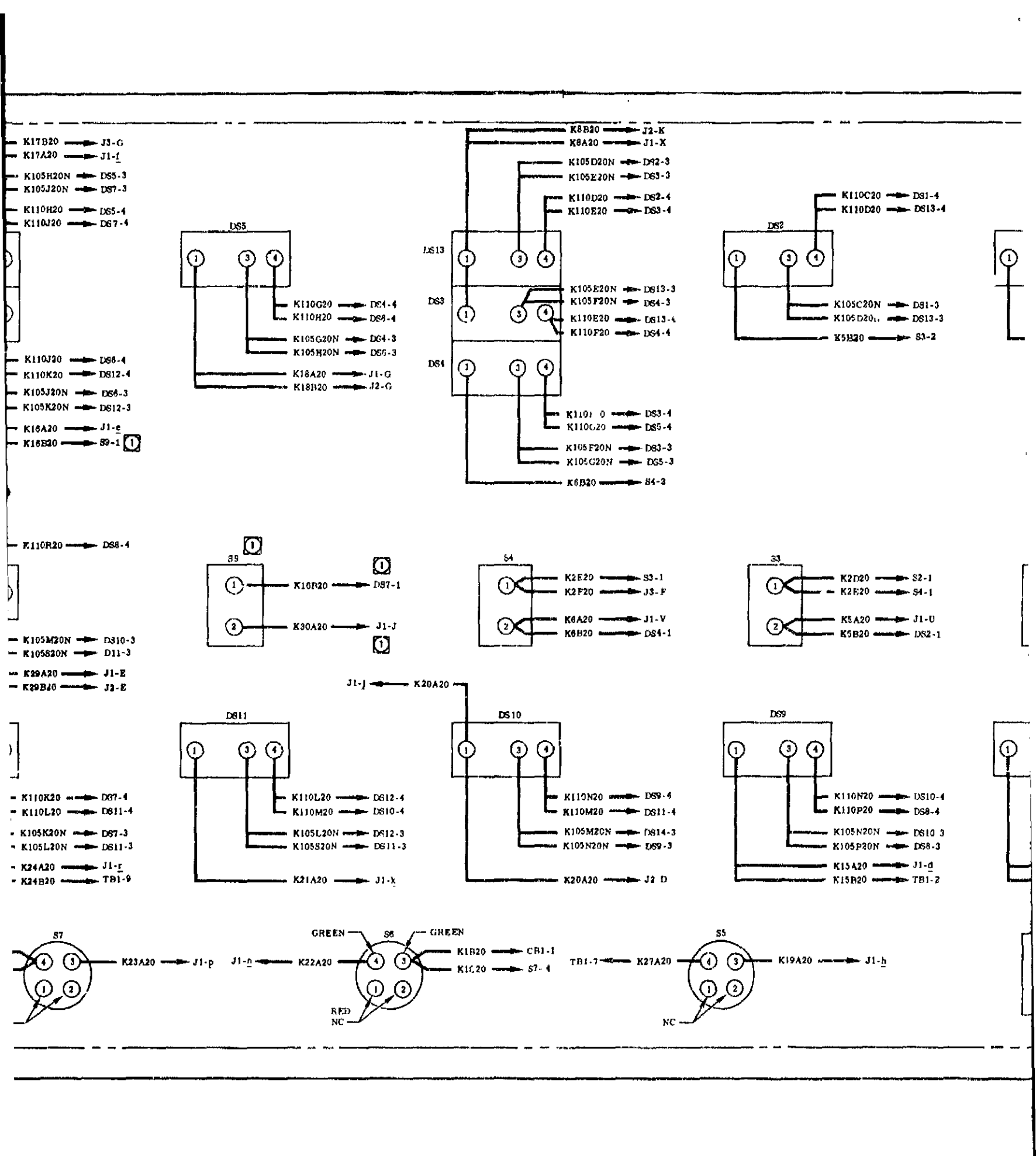
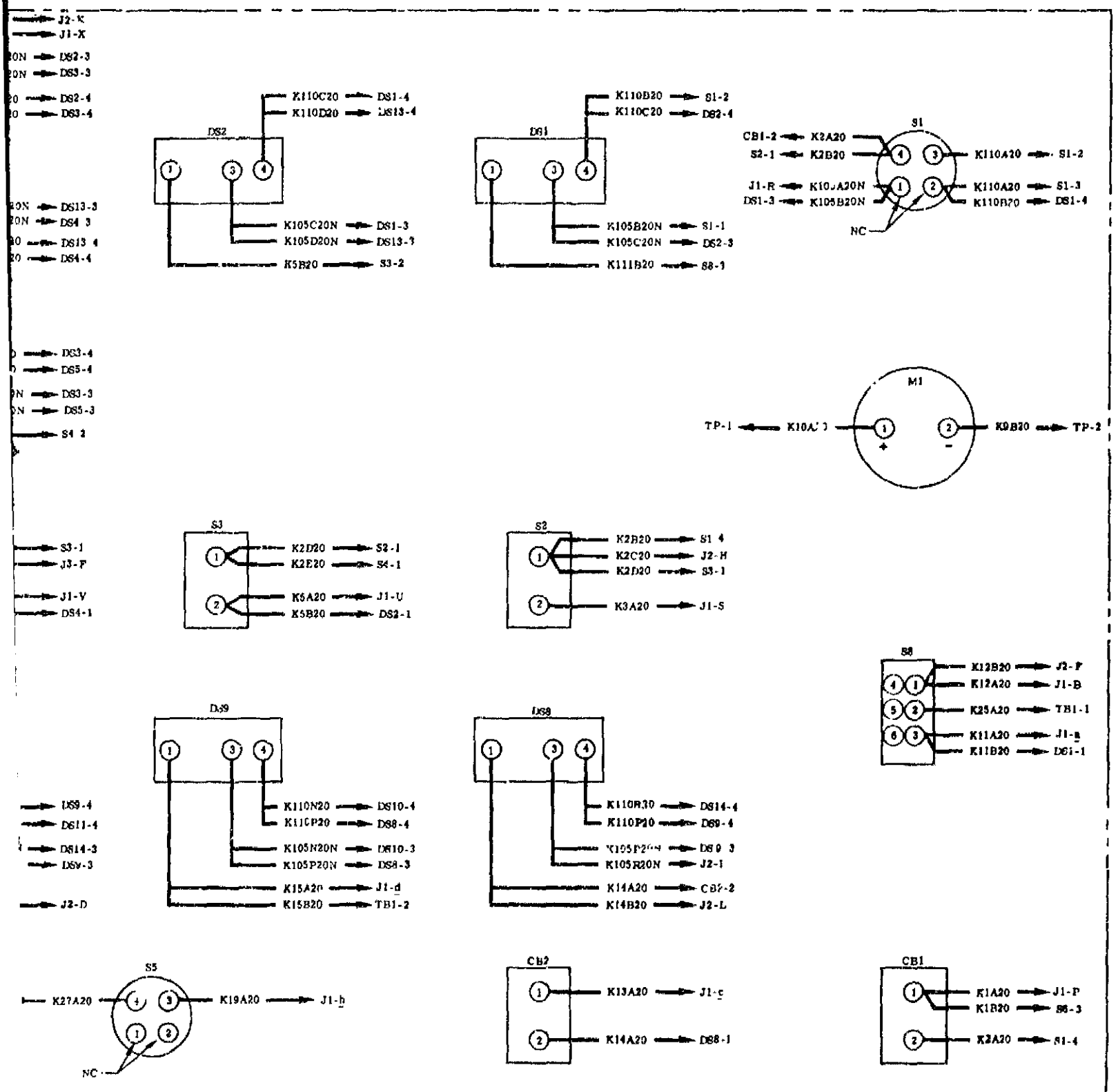
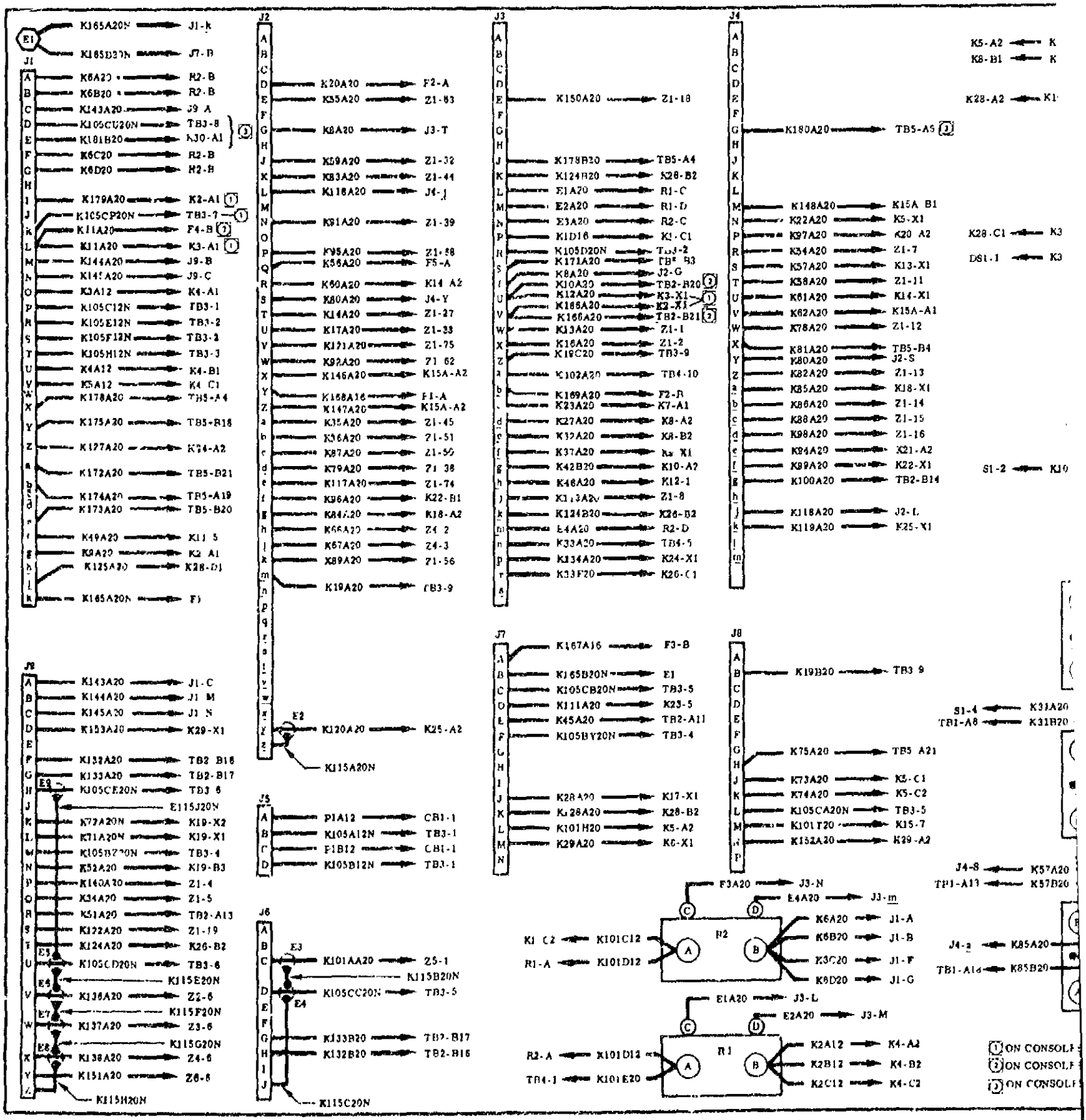


Figure 4-19. Engine Control Panel Wiring Diagram


K17B20 J3-G
K17A20 J1-f
K105H20N DS5-3
K105J20N DS7-3
K110H20 DS5-4
K110J20 DS7-4
K110J20 DS6-4
K110K20 DS12-4
K105J20N DS6-3
K105K20N DS12-3
K16A20 J1-e
K16B20 S9-1
K110R20 DS8-4
K105M20N DS10-3
K105S20N D11-3
K29A20 J1-E
K29B40 J2-E
K110K20 DS7-4
K110L20 DS11-4
K105K20N DS7-3
K105L20N DS11-3
K24A20 J1-r
K24B20 TB1-9
DS5
K110G20 DS4-4
K110H20 DS6-4
K105G20N DS4-3
K105H20N DS6-3
K18A20 J1-G
K18B20 J2-G
K8B20 J2-K
K8A20 J1-X
K105D20N DS2-3
K105E20N DS3-3
K110D20 DS2-4
K110E20 DS3-4
DS13
DS3
DS4
K105E20N DS13-3
K105F20N DS4-3
K110E20 DS13-4
K110F20 DS4-4
K110F20 DS3-4
K110G20 DS5-4
K105F20N DS3-3
K105G20N DS5-3
K6B20 S4-2
K110C20 DS1-4
K110D20 DS13-4
DS2
K105C20N DS1-3
K105D20N DS13-3
K5B20 S3-2
S9
K16B20 DS7-1
K30A20 J1-J
S4
K2E20 S3-1
K2F20 J3-F
K6A20 J1-V
K6B20 DS4-1
S3
K2D20 S2-1
K2E20 S4-1
K5A20 J1-U
K5B20 DS2-1
J1-J K20A20
DS11
K110L20 DS12-4
K110M20 DS10-4
K105L20N DS12-3
K105S20N DS11-3
K21A20 J1-k
DS10
K110N20 DS9-4
K110M20 DS11-4
K105M20N DS11-3
K105N20N DS9-3
K20A20 J2 D
DS9
K110N20 DS10-4
K110P20 DS8-4
K105N20N DS10-3
K105P20N DS8-3
K15A20 J1-d
K15B20 TB1-2
S7
K23A20 J1-p
GREEN
S6
GREEN
J1-n K22A20
K1B20 CB1-1
K1C20 S7-4
RED
NC
TB1-7 K27A20
S5
K19A20 J1-h
NC


J2-X
J1-X
DS2-3
DS3-3
DS2-4
DS3-4
DS13-3
DS4-3
DS13-4
DS4-4
DS3-4
DS5-4
DS3-3
DS5-3
S4-2
S3-1
J3-F
J1-V
DS4-1
DS9-4
DS11-4
DS14-3
DS9-3
J2-D
S5
K27A20
K19A20
J1-h
NC
DS2
K110C20
DS1-4
K110D20
DS13-4
K105C20N
DS1-3
K105D20N
DS13-3
K5B20
S3-2
DS1
K110B20
S1-2
K110C20
DS2-4
K105B20N
S1-1
K105C20N
DS2-3
K111B20
S8-1
S1
CB1-2
K2A20
S2-1
K2B20
K110A20
S1-2
J1-R
K105A20N
DS1-3
K105B20N
K110A20
S1-3
K110B20
DS1-4
NC
M1
TP-1
K10A20
K9B20
TP-2
+
-
S3
K2D20
S2-1
K2E20
S4-1
K5A20
J1-U
K5B20
DS2-1
S2
K2B20
S1-4
K2C20
J2-H
K2D20
S3-1
K3A20
J1-S
S8
K12B20
J2-F
K12A20
J1-B
K25A20
TB1-1
K11A20
J1-a
K11B20
DS1-1
DS9
K110N20
DS10-4
K110P20
DS8-4
K105N20N
DS10-3
K105P20N
DS8-3
K15A20
J1-d
K15B20
TB1-2
DS8
K110R30
DS14-4
K110P10
DS9-4
K105P20N
DS9-3
K105R20N
J2-1
K14A20
CB2-2
K14B20
J2-L
CB2
K13A20
J1-c
K14A20
DS8-1
CB1
K1A20
J1-P
K1B20
S6-3
K2A20
S1-4


J1
J2
J3
J4
J7
J8
J9
J5
J6
E1
E2
E3
E4
E5
E6
E7
E8
E9
B1
B2
ON CONSOLE
ON CONSOLE
ON CONSOLE

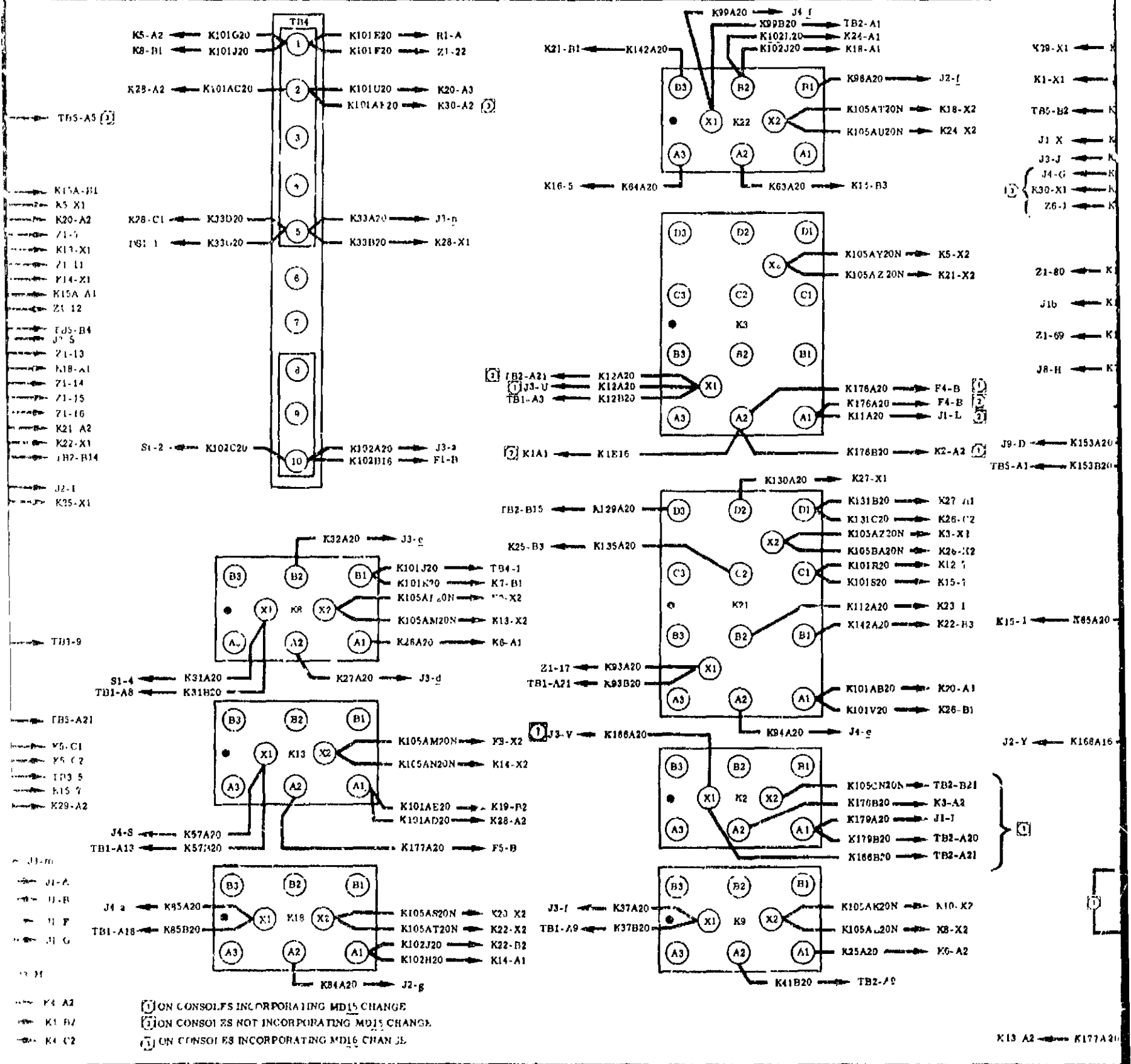


Figure 4-20. Ground Relay Panel Wiri

Ch

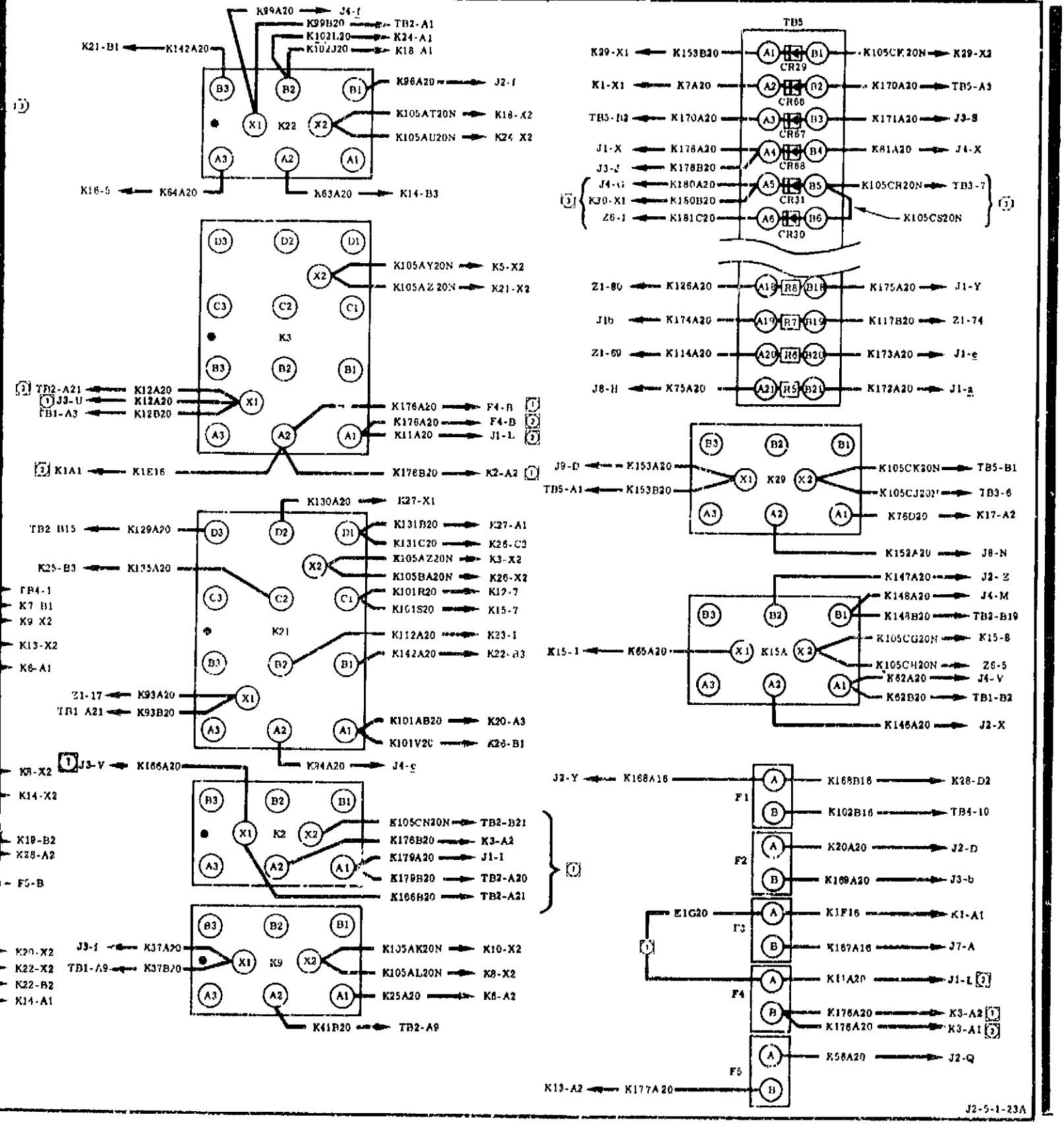


Figure 4-20. Ground Relay Panel Wiring Diagram (Sheet 1 of 3)

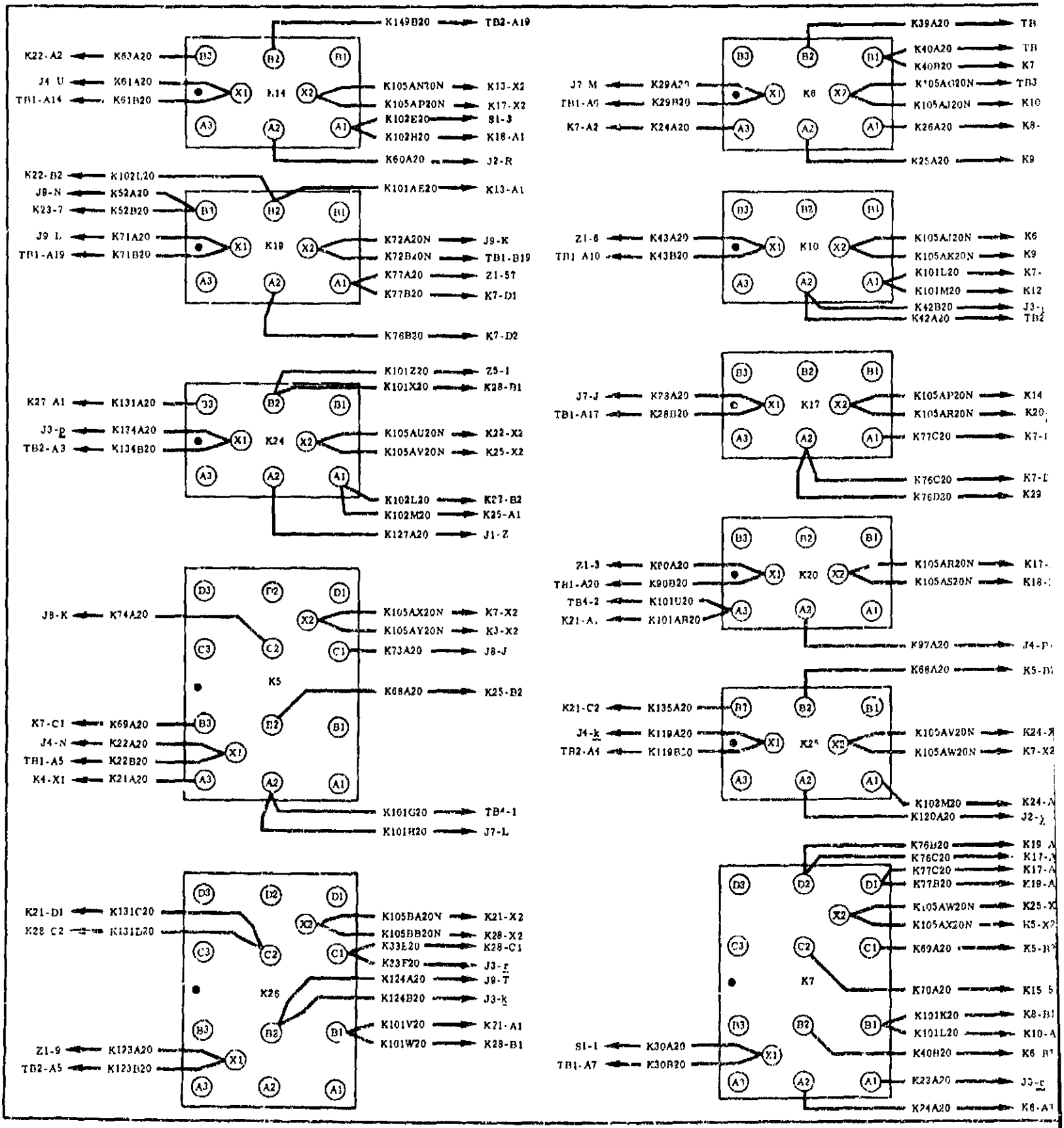
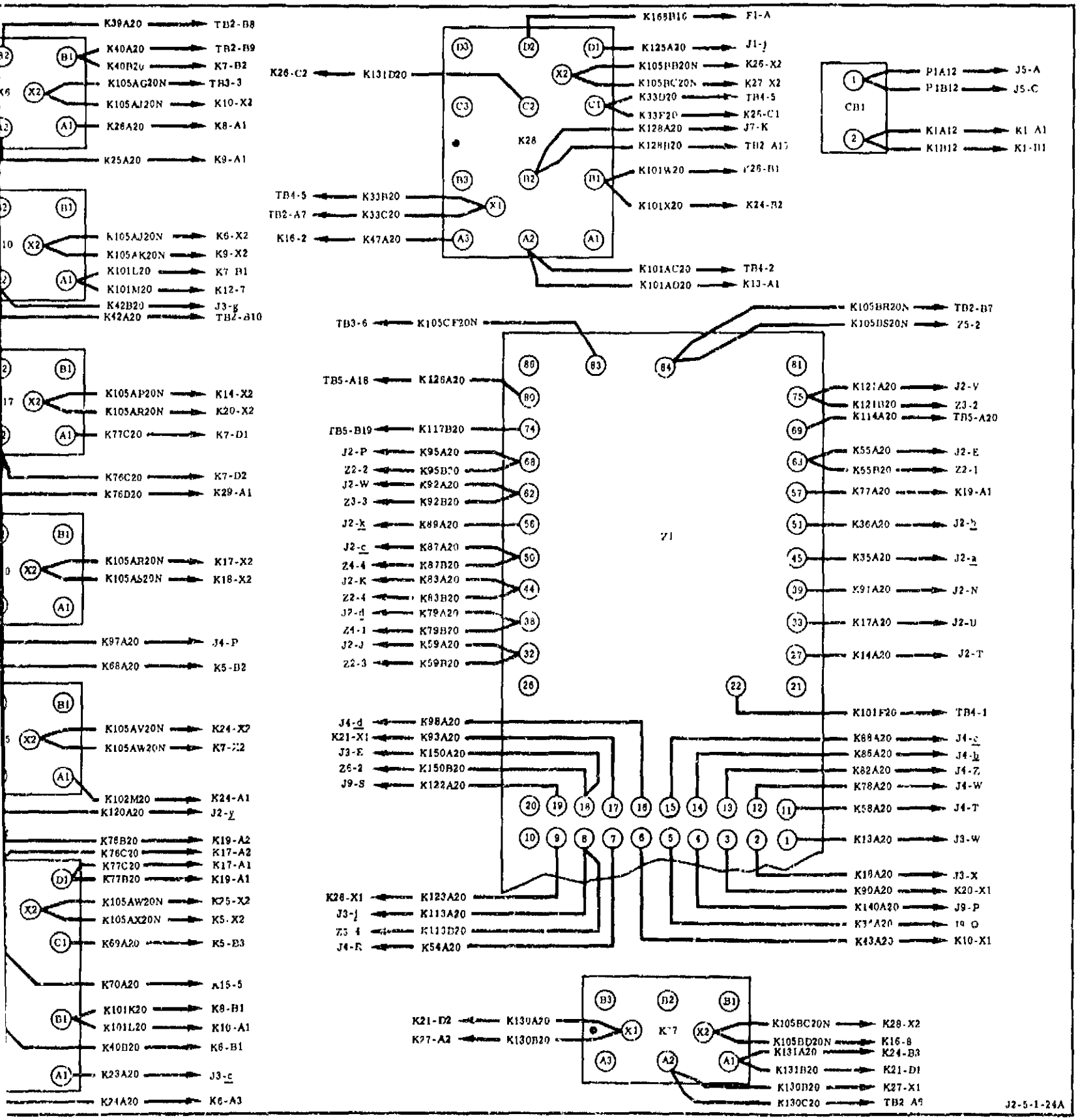
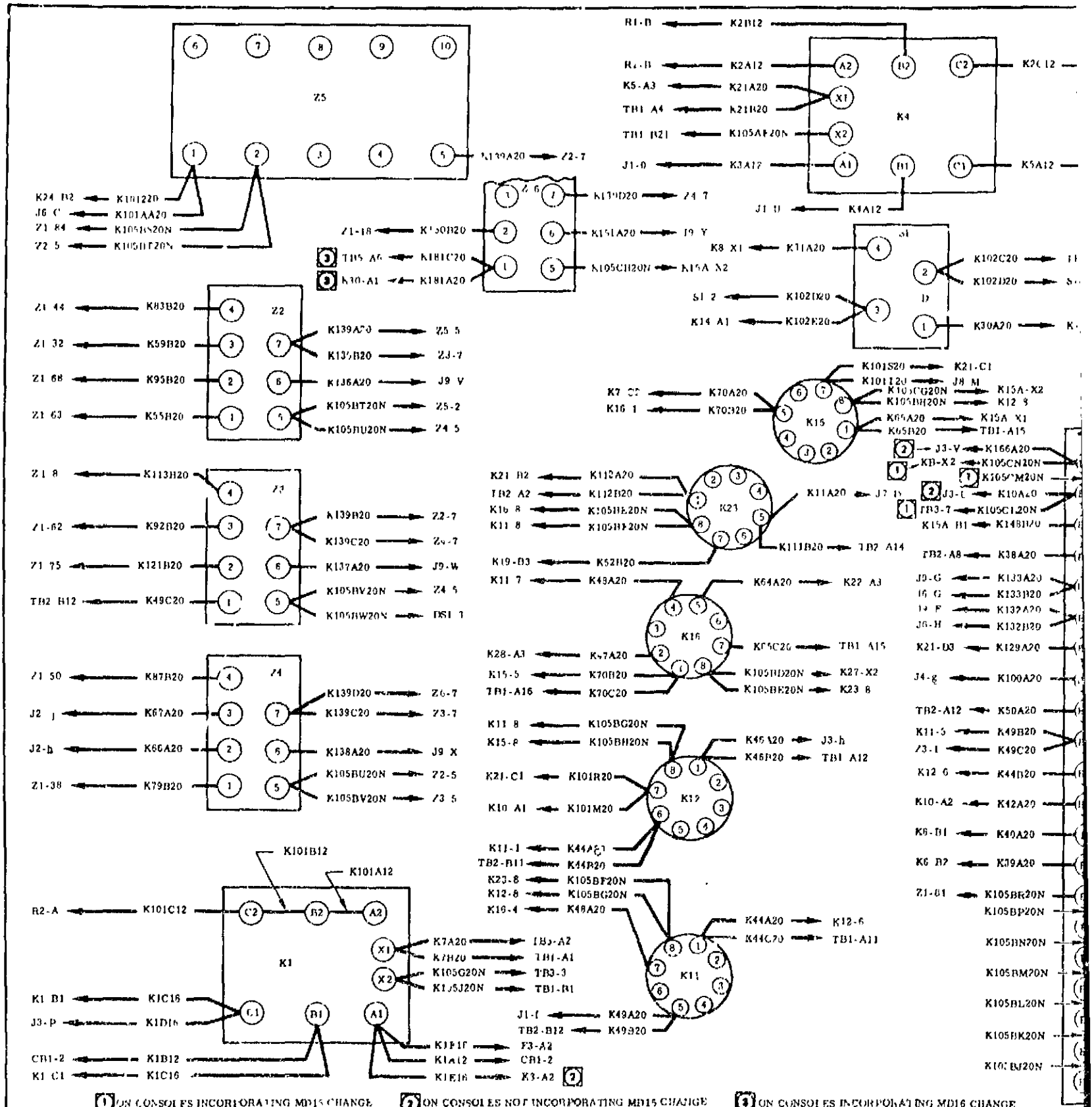


Figure 4-20. Ground Relay Panel Wiring Diagram (Sheet 2 of 3)


K39A20 TB2-B8
K40A20 TB2-B9
K40B20 K7-B2
K105AG20N TB3-3
K105AJ20N K10-X2
K26A20 K8-A1
K25A20 K9-A1
K105AJ20N K6-X2
K105AK20N K9-X2
K101L20 K7-B1
K101M20 K12-7
K42B20 J3-g
K42A20 TB2-B10
K105AP20N K14-X2
K105AR20N K20-X2
K77C20 K7-D1
K76C20 K7-D2
K76D20 K29-A1
K105AR20N K17-X2
K105AS20N K18-X2
K97A20 J4-P
K68A20 K5-B2
K105AV20N K24-X2
K105AW20N K7-X2
K102M20 K24-A1
K120A20 J2-y
K76B20 K19-A2
K76C20 K17-A2
K77C20 K17-A1
K77B20 K19-A1
K105AW20N K25-X2
K105AX20N K5-X2
K69A20 K5-B3
K70A20 A15-5
K101K20 K8-B1
K101L20 K10-A1
K40D20 K6-B1
K23A20 J3-c
K24A20 K6-A3
K26-C2 K131D20
TB4-5 K33B20
TB2-A7 K33C20
K16-2 K47A20
K168B16 F1-A
K125A20 J1-j
K105BB20N K26-X2
K105BC20N K27-X2
K33D20 TB4-5
K33F20 K26-C1
K128A20 J7-K
K128B20 TB2-A17
K101W20 K26-B1
K101X20 K24-B2
K101AC20 TB4-2
K101AD20 K13-A1
P1A12 J5-A
P1B12 J5-C
K1A12 K1-A1
K1B12 K1-B1
TB3-6 K105CF20N
K105BR20N TB2-B7
K105BS20N Z5-2
TB5-A18 K128A20
TB5-B19 K117B20
J2-P K95A20
Z2-2 K95B20
J2-W K92A20
Z3-3 K92B20
J2-k K89A20
J2-c K87A20
Z4-4 K87B20
J2-K K83A20
Z2-4 K83B20
J2-d K79A20
Z4-1 K79B20
J2-J K59A20
Z2-3 K59B20
K121A20 J2-V
K121B20 Z3-2
K114A20 TB5-A20
K55A20 J2-E
K55B20 Z2-1
K77A20 K19-A1
K36A20 J2-b
K35A20 J2-a
K91A20 J2-N
K17A20 J2-U
K14A20 J2-T
K101F20 TB4-1
J4-d K98A20
K21-X1 K93A20
J3-E K150A20
Z6-2 K150B20
J9-S K122A20
K88A20 J4-c
K86A20 J4-b
K82A20 J4-Z
K78A20 J4-W
K58A20 J4-T
K13A20 J3-W
K18A20 J3-X
K90A20 K20-X1
K140A20 J9-P
K43A20 K10-X1
K28-X1 K123A20
J3-j K113A20
Z5-4 K113B20
J4-R K54A20
K21-D2 K130A20
K27-A2 K130B20
K105BC20N K28-X2
K105BD20N K16-8
K131A20 K24-B3
K131B20 K21-D1
K130D20 K27-X1
K130C20 TB2-A9
J2-5-1-24A



[1] ON CONSOLES INCORPORATING MD15 CHANGE [2] ON CONSOLES NOT INCORPORATING MD15 CHANGE [3] ON CONSOLES INCORPORATING MD16 CHANGE

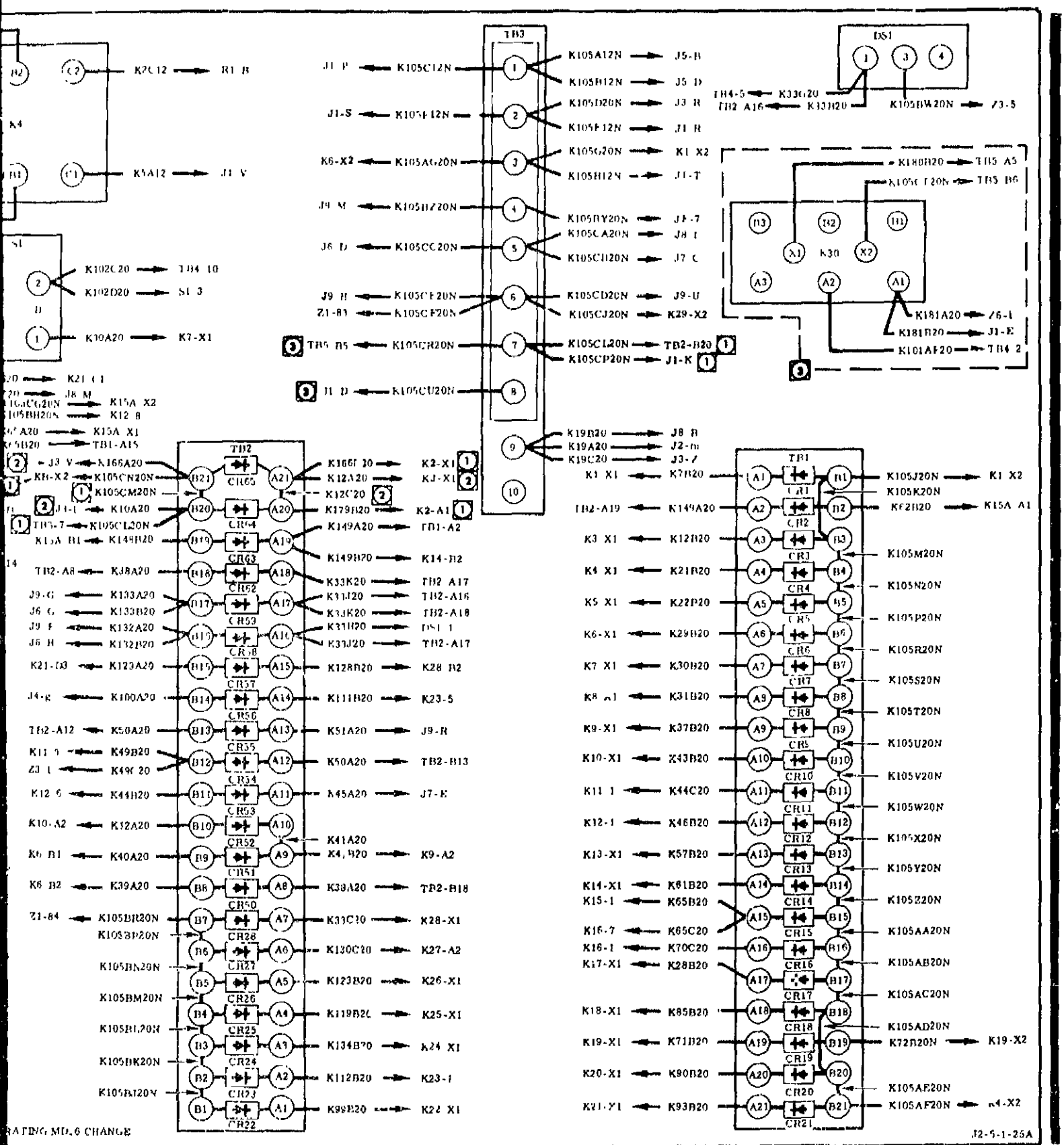


Figure 4-20. Ground Relay Panel Wiring Diagram (Sheet 3 of 3)

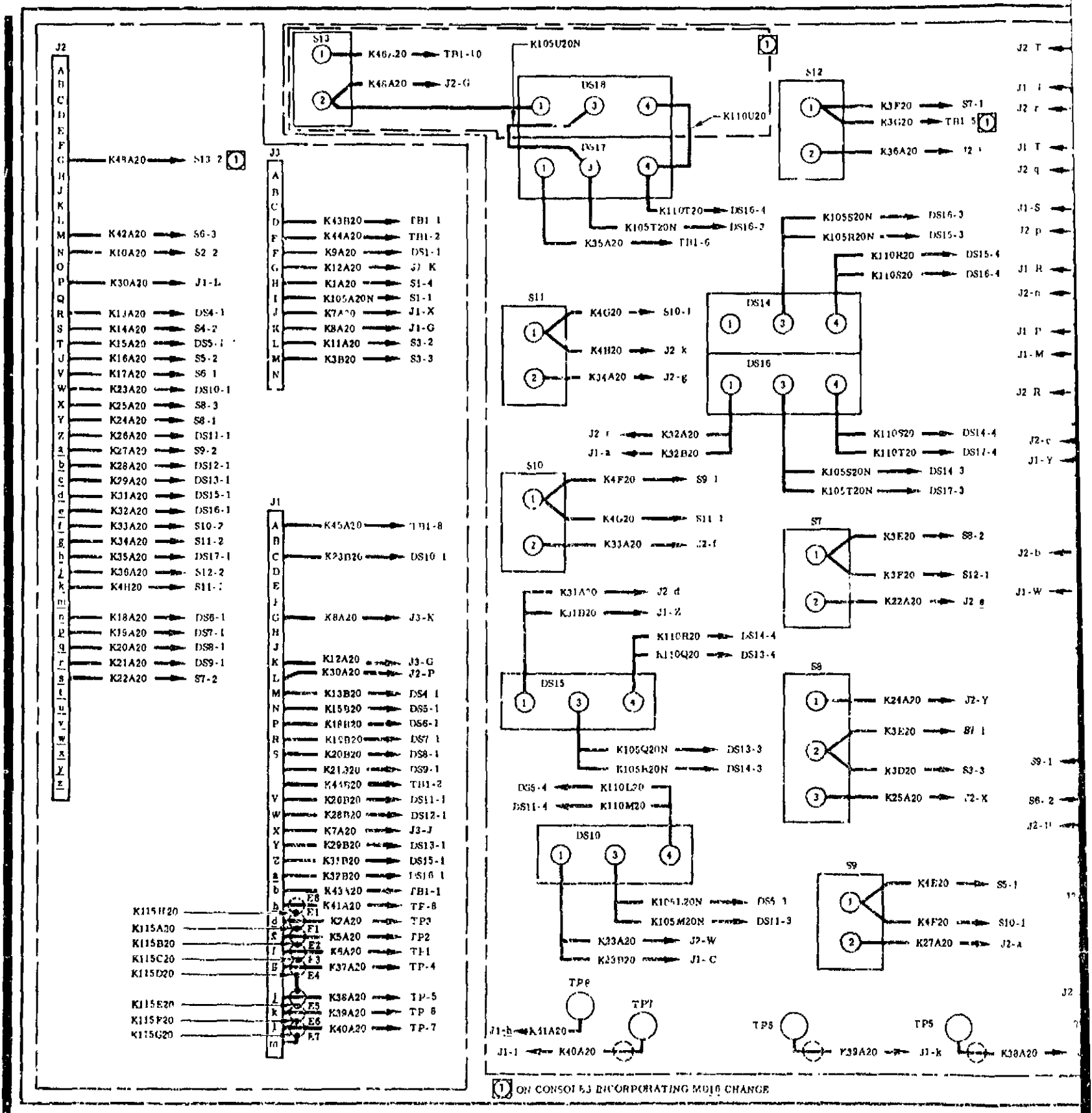
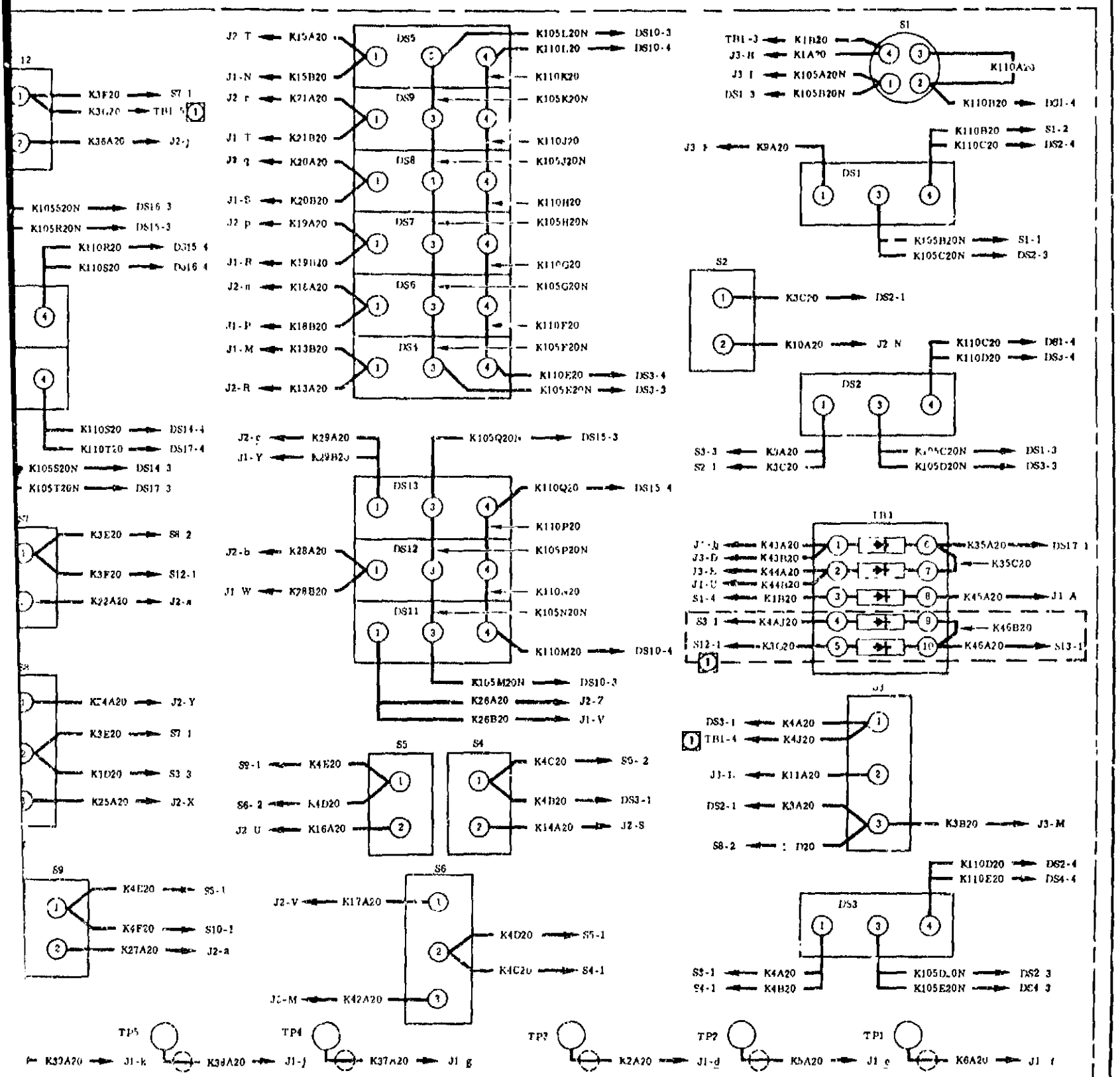
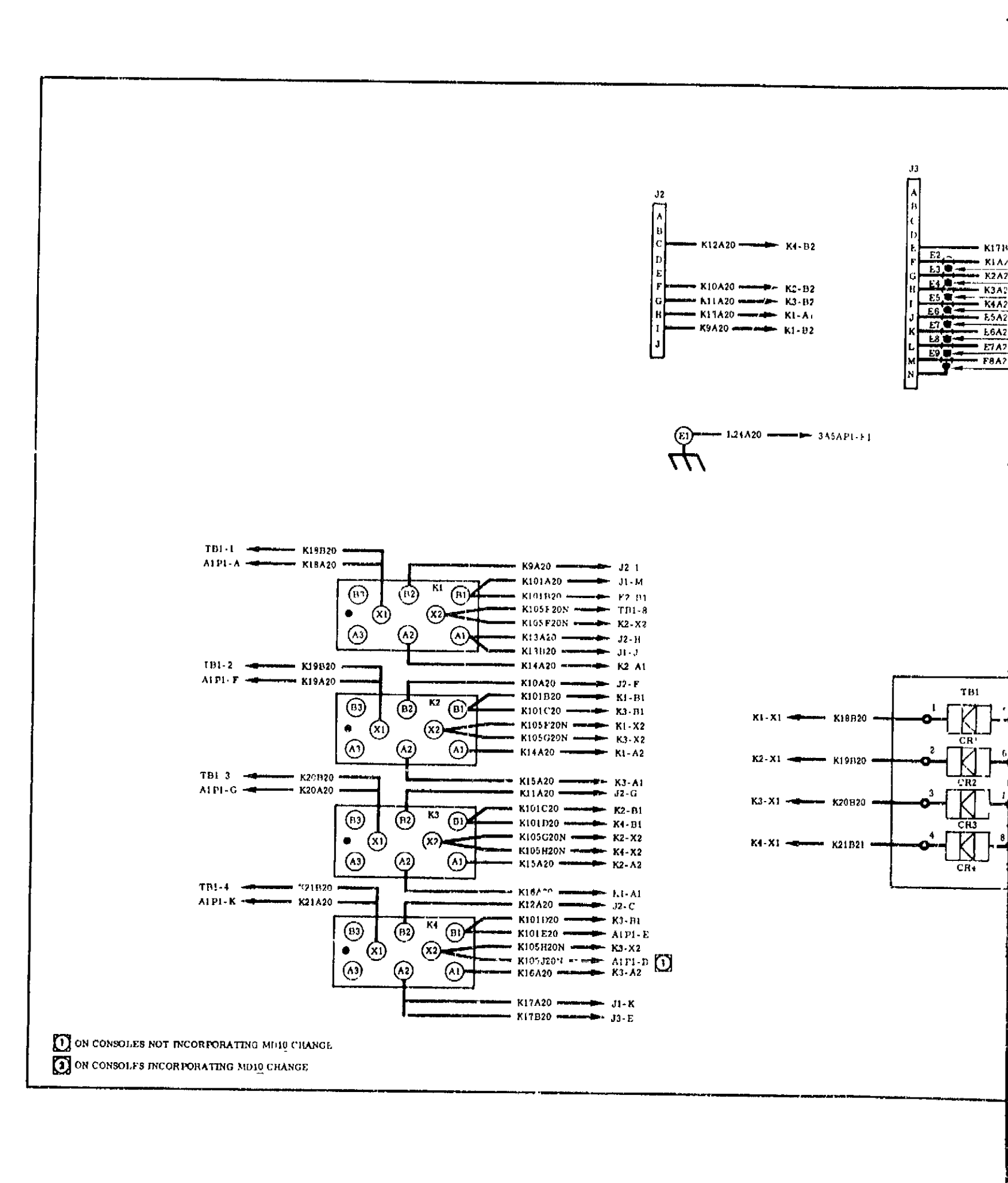


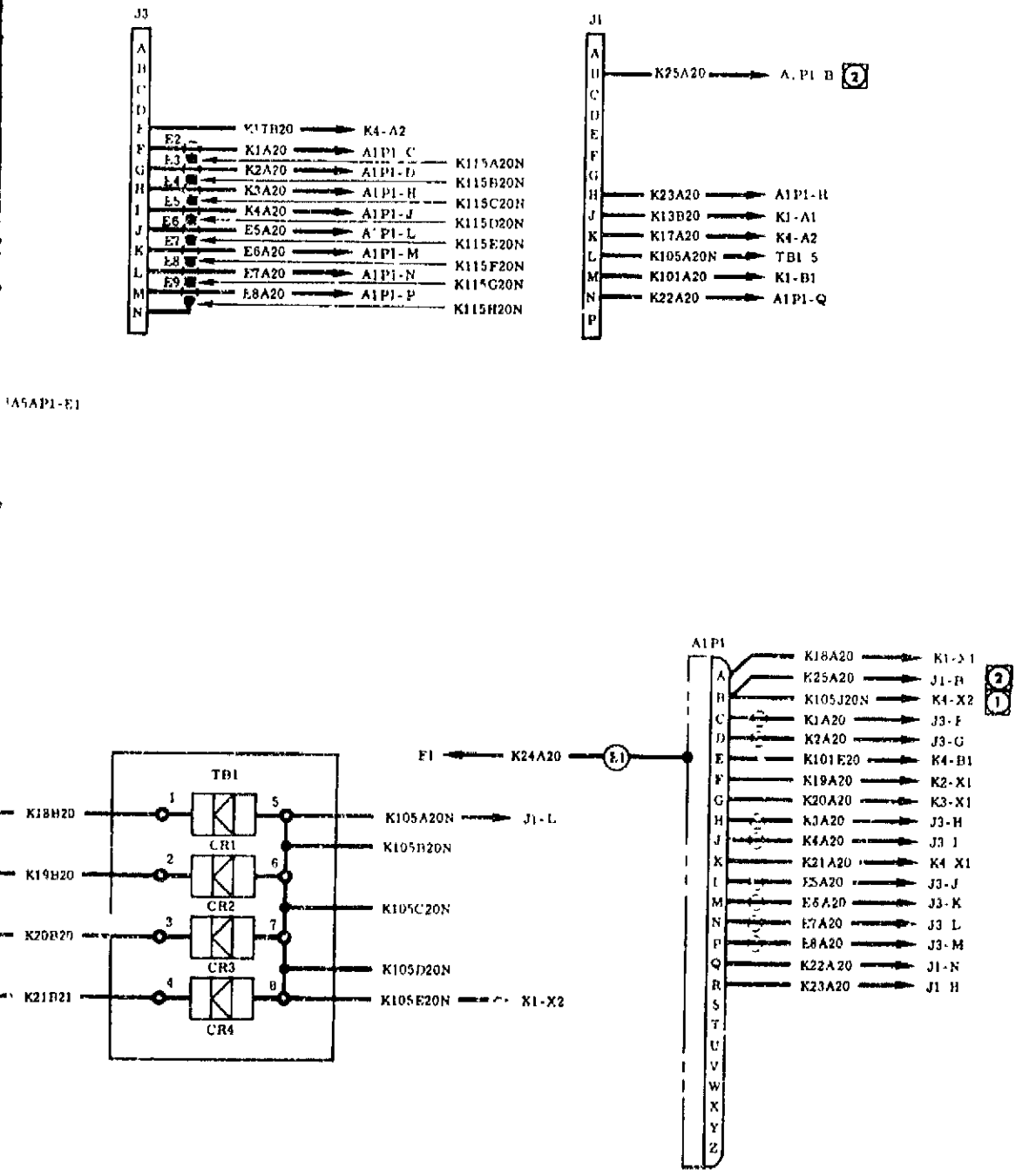
Figure 4-21. Engine Test Monitor Panel Wiring Diagram


J2 T K15A20
J1-N K15B20
J2 r K21A20
J1 T K21B20
J2 q K20A20
J1-S K20B20
J2 p K19A20
J1-R K19B20
J2-n K18A20
J1-P K18B20
J1-M K13B20
J2-R K13A20
DS5
DS9
DS8
DS7
DS6
DS4
K105L20N DS10-3
K110L20 DS10-4
K110K20
K105K20N
K110J20
K105J20N
K110H20
K105H20N
K110G20
K105G20N
K110F20
K105F20N
K110E20 DS3-4
K105E20N DS3-3
J2-c K29A20
J1-Y K29B20
DS13
DS12
DS11
K105Q20N DS15-3
K110Q20 DS15-4
K110P20
K105P20N
K110N20
K105N20N
K110M20 DS10-4
K105M20N DS10-3
K26A20 J2-7
K26B20 J1-V
J2-b K28A20
J1 W K28B20
S1
TB1-3 K1B20
J3-R K1A20
J3 I K105A20N
DS1 3 K105B20N
K110A20
K110B20 DS1-4
J3 P K9A20
DS1
K110B20 S1-2
K110C20 DS2-4
K105B20N S1-1
K105C20N DS2-3
S2
K3C20 DS2-1
K10A20 J2 N
DS2
K110C20 DS1-4
K110D20 DS3-4
S3-3 K3A20
S2 1 K3C20
K105C20N DS1-3
K105D20N DS3-3
TB1
J3-b K43A20
J3-D K43B20
J3-L K44A20
J1-U K44B20
S1-4 K1B20
S3 1 K4AJ20
S12-1 K3C20
K35A20 DS17 1
K35C20
K45A20 J1 A
K46B20
K46A20 S13-1
S3
DS3-1 K4A20
TB1-4 K4J20
J3-L K11A20
DS2-1 K3A20
S8-2 K20
K3B20 J3-M
S7
K3E20 S8 2
K3F20 S12-1
K22A20 J2-a
S8
K24A20 J2-Y
K3E20 S7 1
K1D20 S3 3
K25A20 J2-X
S5
S9-1 K4E20
S6-2 K4D20
J2 U K16A20
S4
K4C20 S9-2
K4D20 DS3-1
K14A20 J2-S
S9
K4E20 S5-1
K4F20 S10-1
K27A20 J2-a
S6
J2-V K17A20
K4D20 S5-1
K4C20 S4-1
J2-M K42A20
K110D20 DS2-4
K110E20 DS4-4
DS3
S3-1 K4A20
S4-1 K4B20
K105D20N DS2 3
K105E20N DS4 3
12
K3F20 S7 1
K3G20 TB1 5
K36A20 J2-j
K105S20N DS16 3
K105R20N DS15-3
K110R20 DS15 4
K110S20 DS16 4
K110S20 DS14-4
K110T20 DS17-4
K105S20N DS14 3
K105T20N DS17 3
TP5
TP4
TP3
TP2
TP1
K39A20 J1-k
K38A20 J1-j
K37A20 J1 g
K2A20 J1-d
K5A20 J1 e
K6A20 J1 f



1 ON CONSOLES NOT INCORPORATING MD10 CHANGE

2 ON CONSOLES INCORPORATING MD10 CHANGE



9019617-W-1

Figure 4-22. Spark Monitor Panel Wiring Diagram

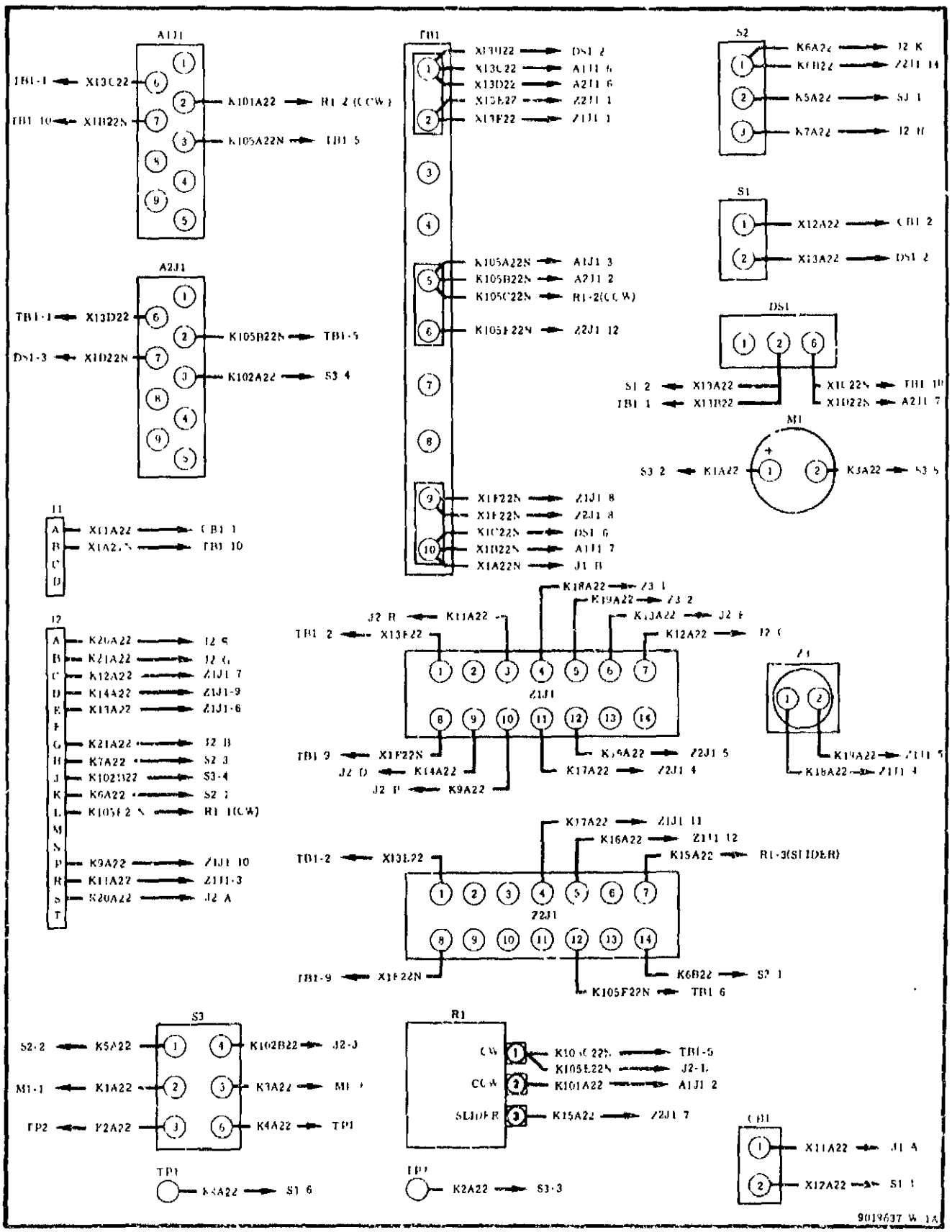
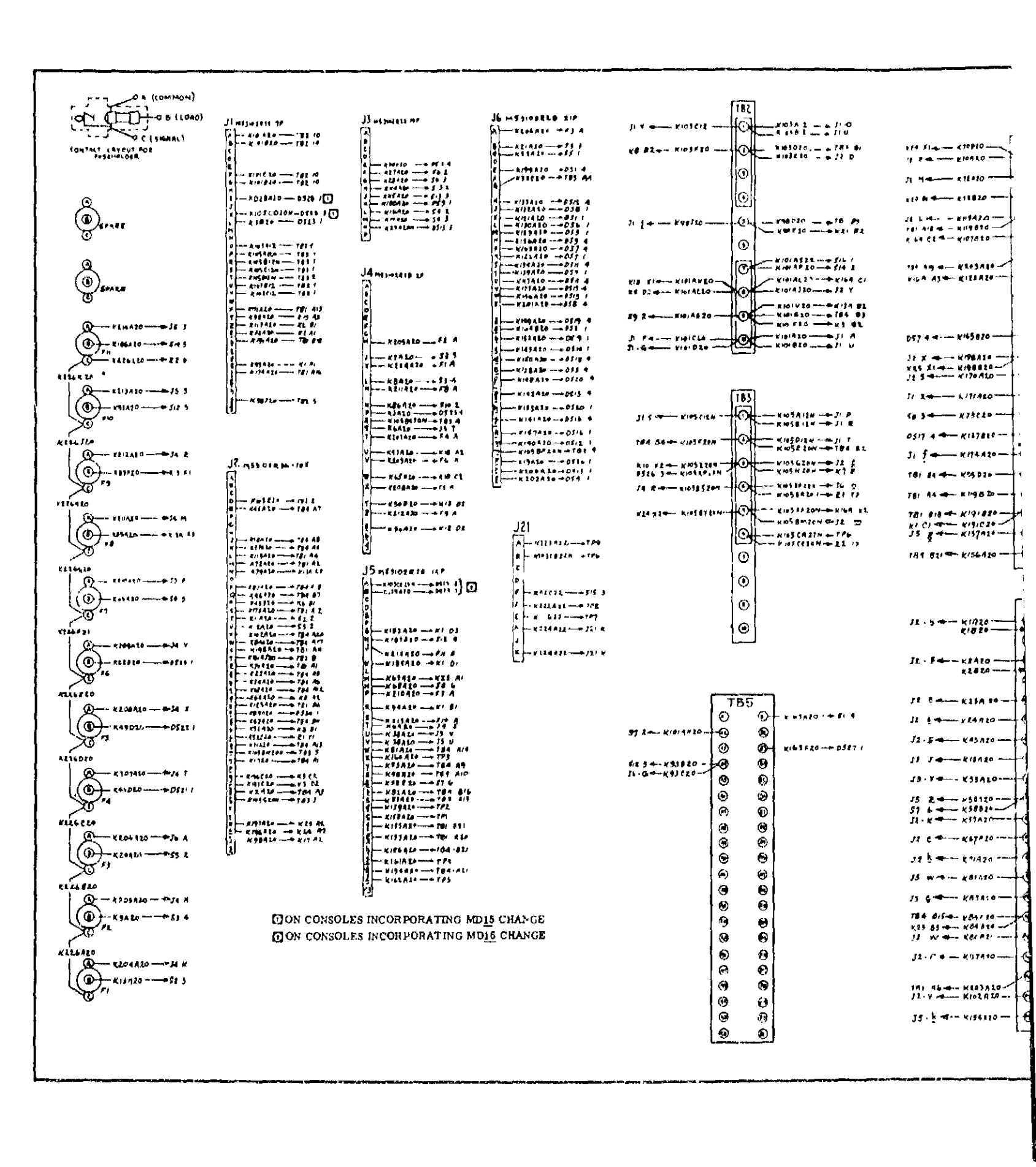


Figure 4-23. Propellant Utilization Valve Position Controller Panel Wiring Diagram


A (COMMON)
B (LOAD)
C (SIGNAL)
CONTACT LAYOUT FOR PUSHHOLDER
SPARE
SPARE
TB2
TB3
TB5
J21
J1
J2
J3
J4
J5
J6
1 ON CONSOLES INCORPORATING MD15 CHANGE
2 ON CONSOLES INCORPORATING MD16 CHANGE

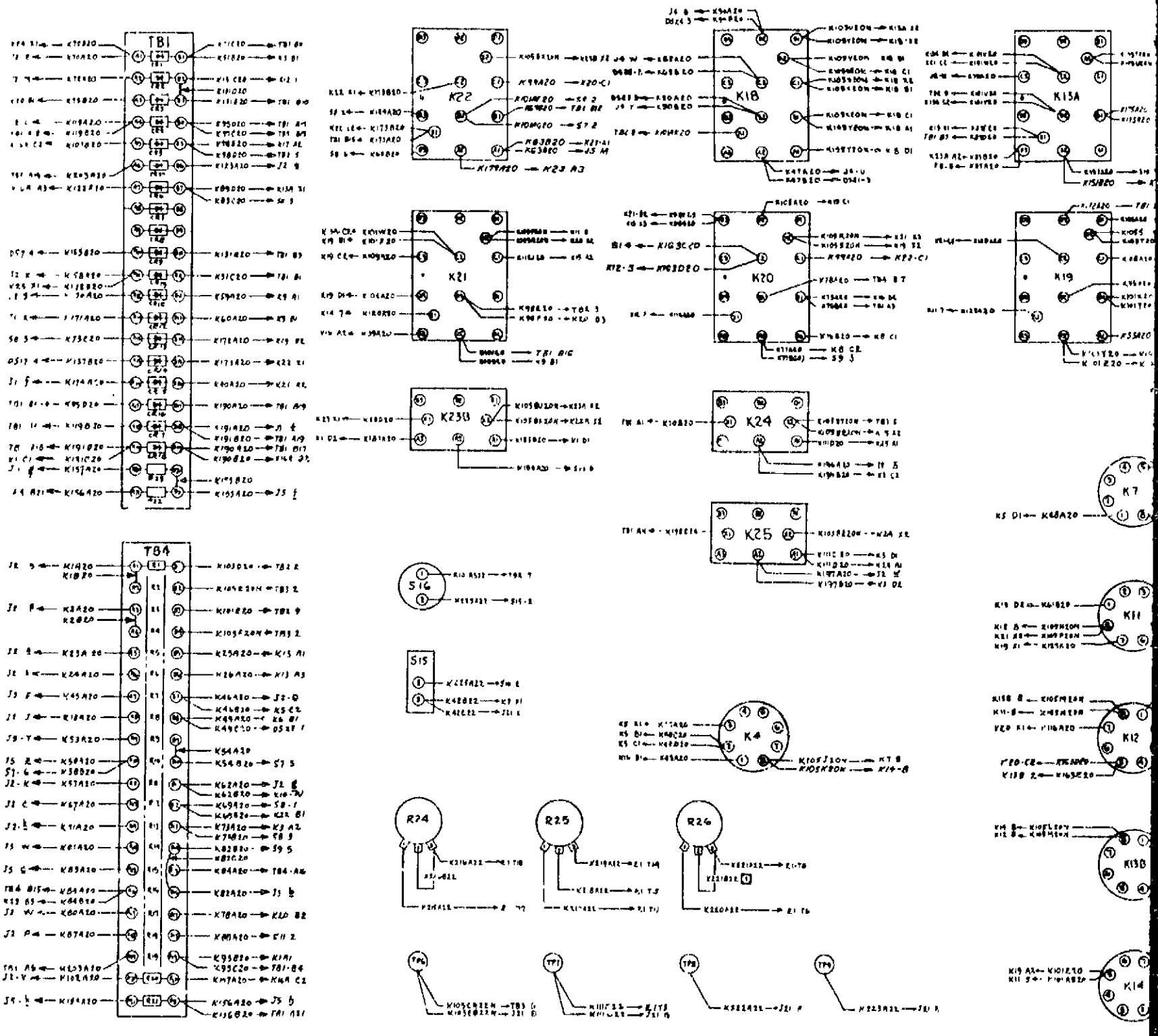


Figure 4-24. Simulator

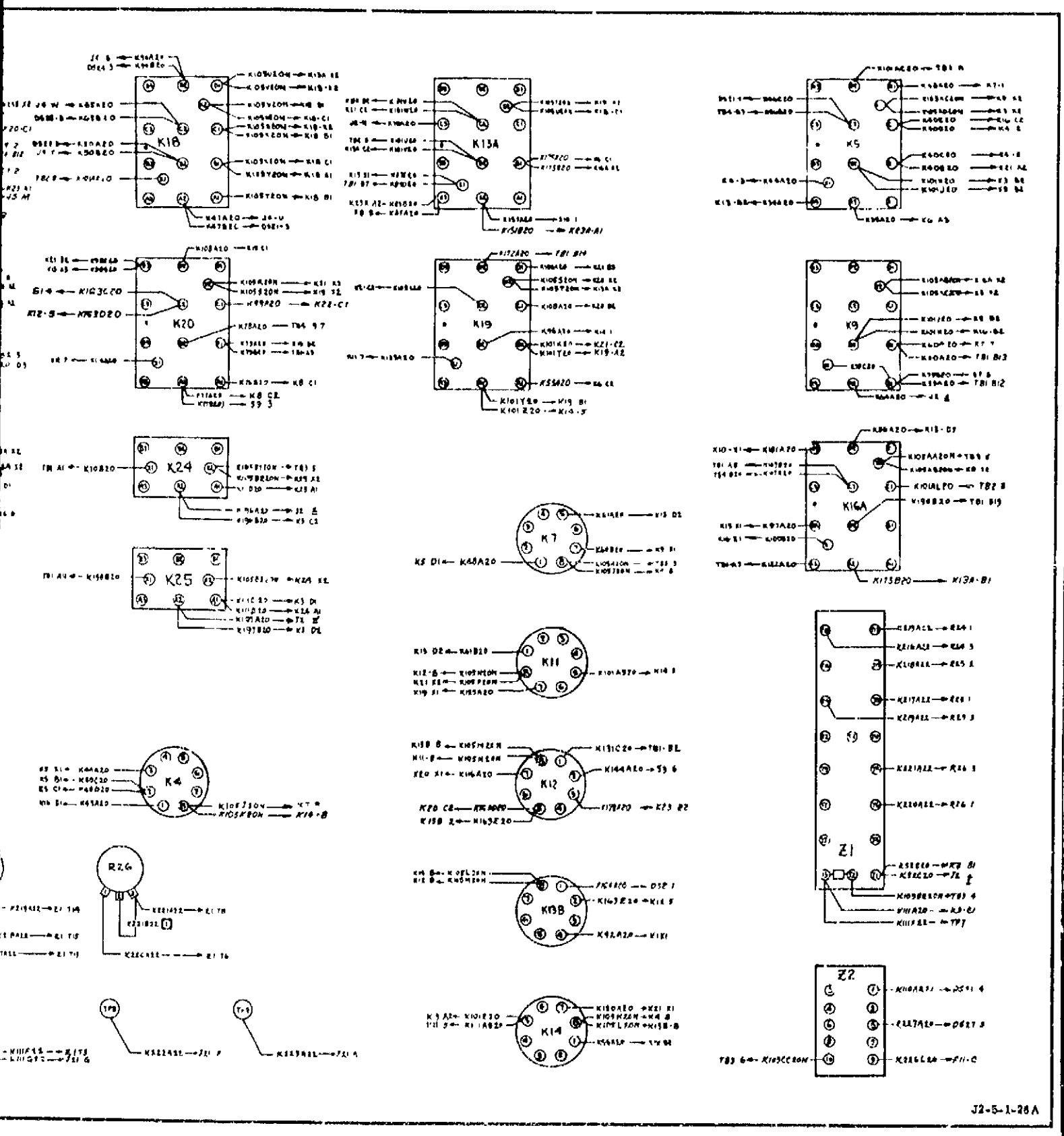


Figure 4-24. Simulator Panel Wiring Diagram (Sheet 1 of 2)

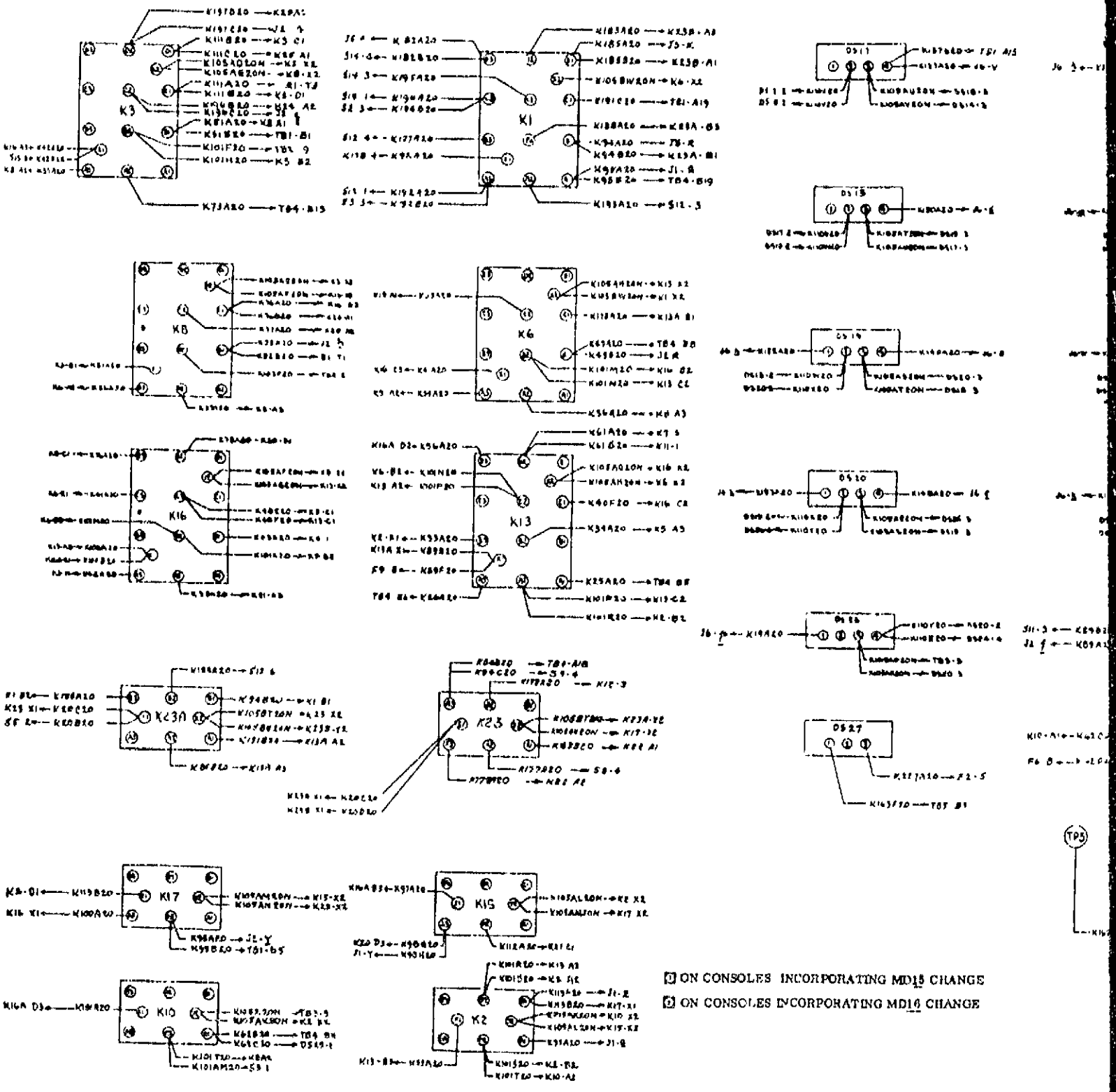
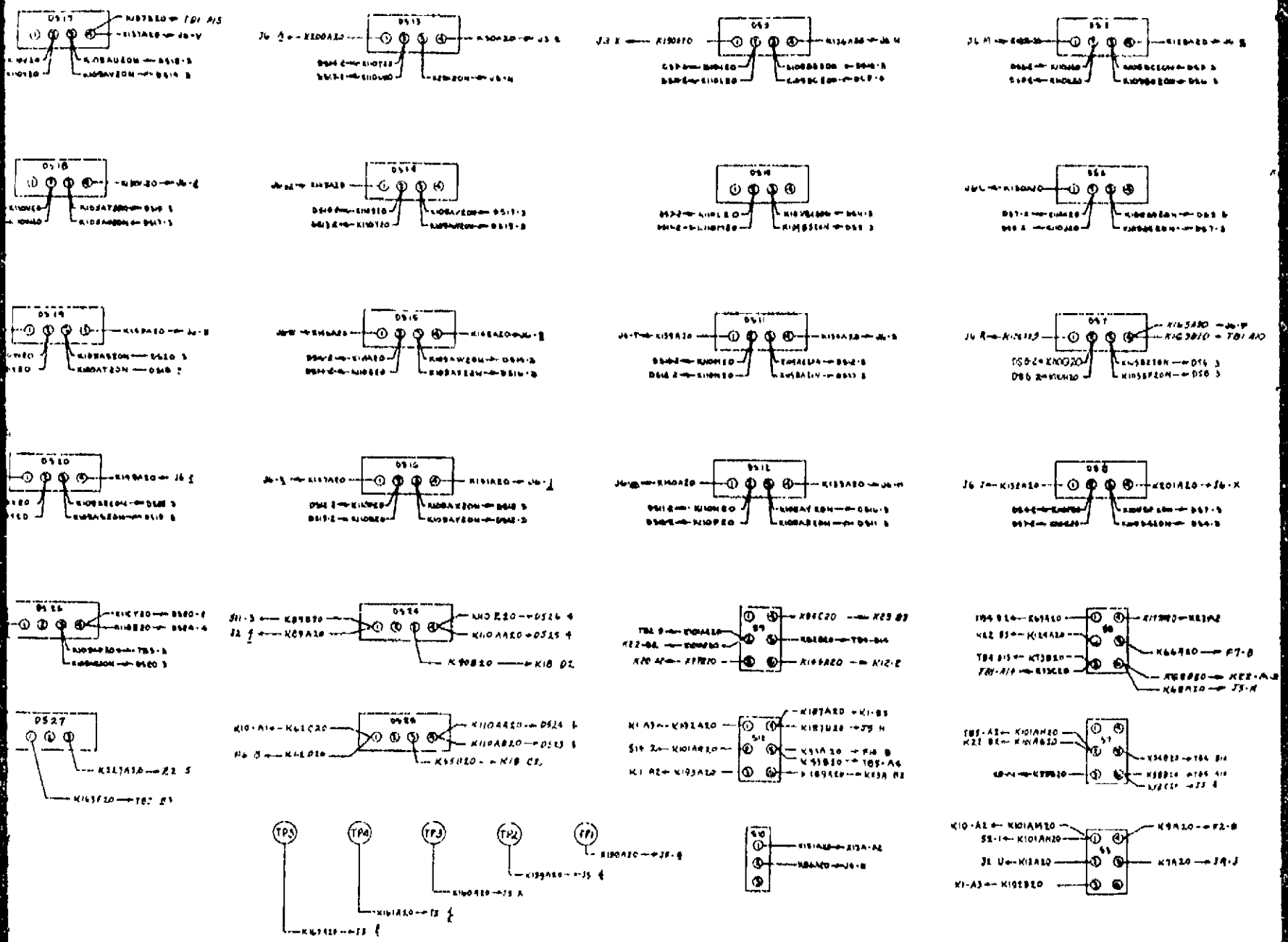
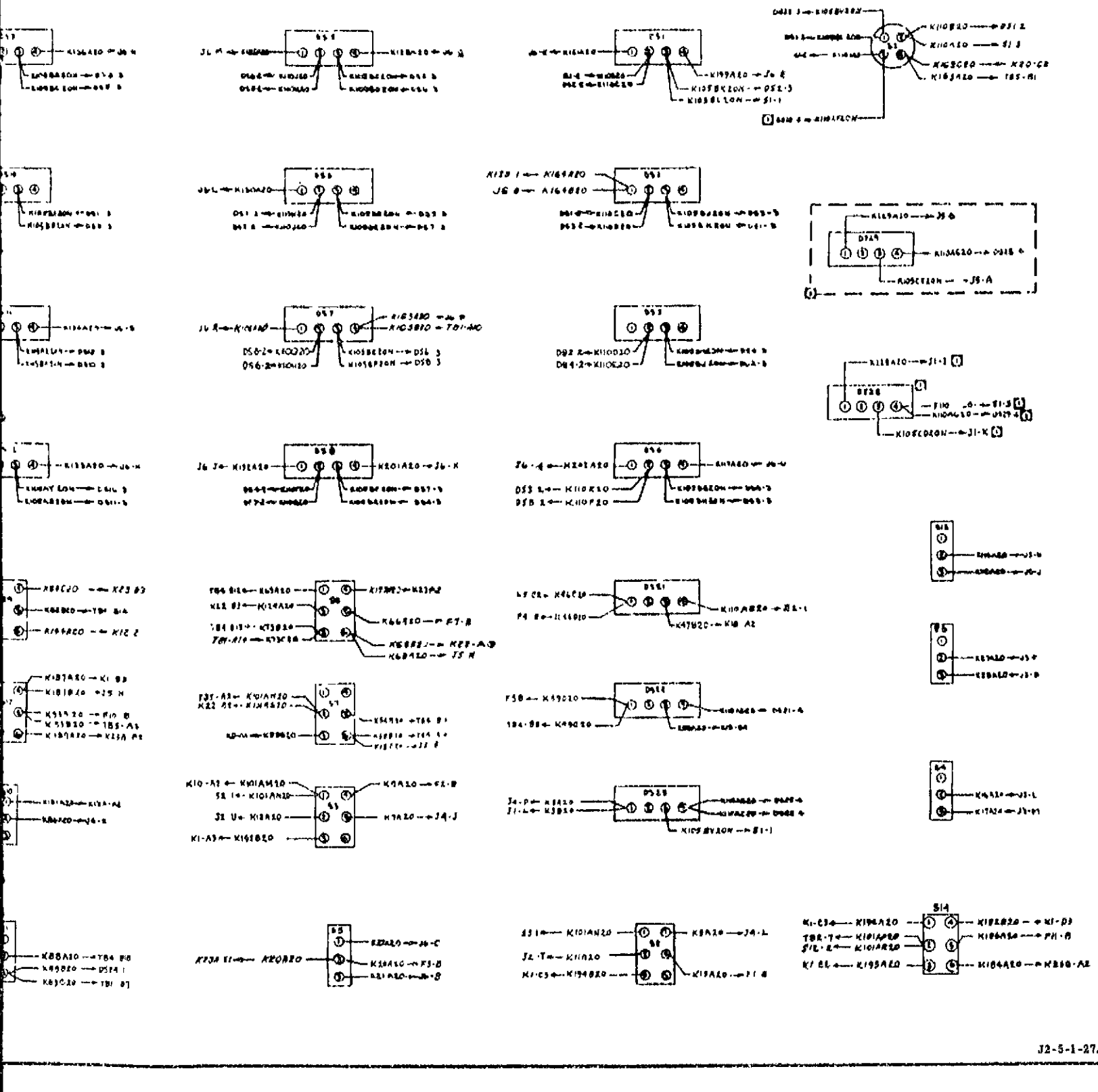


Figure 4-24. Simulator Panel Wiring Diagram (Sheet 2 of 2)



RPORATING Mu15 CHANGE

RPORATING MD10 CHANGE



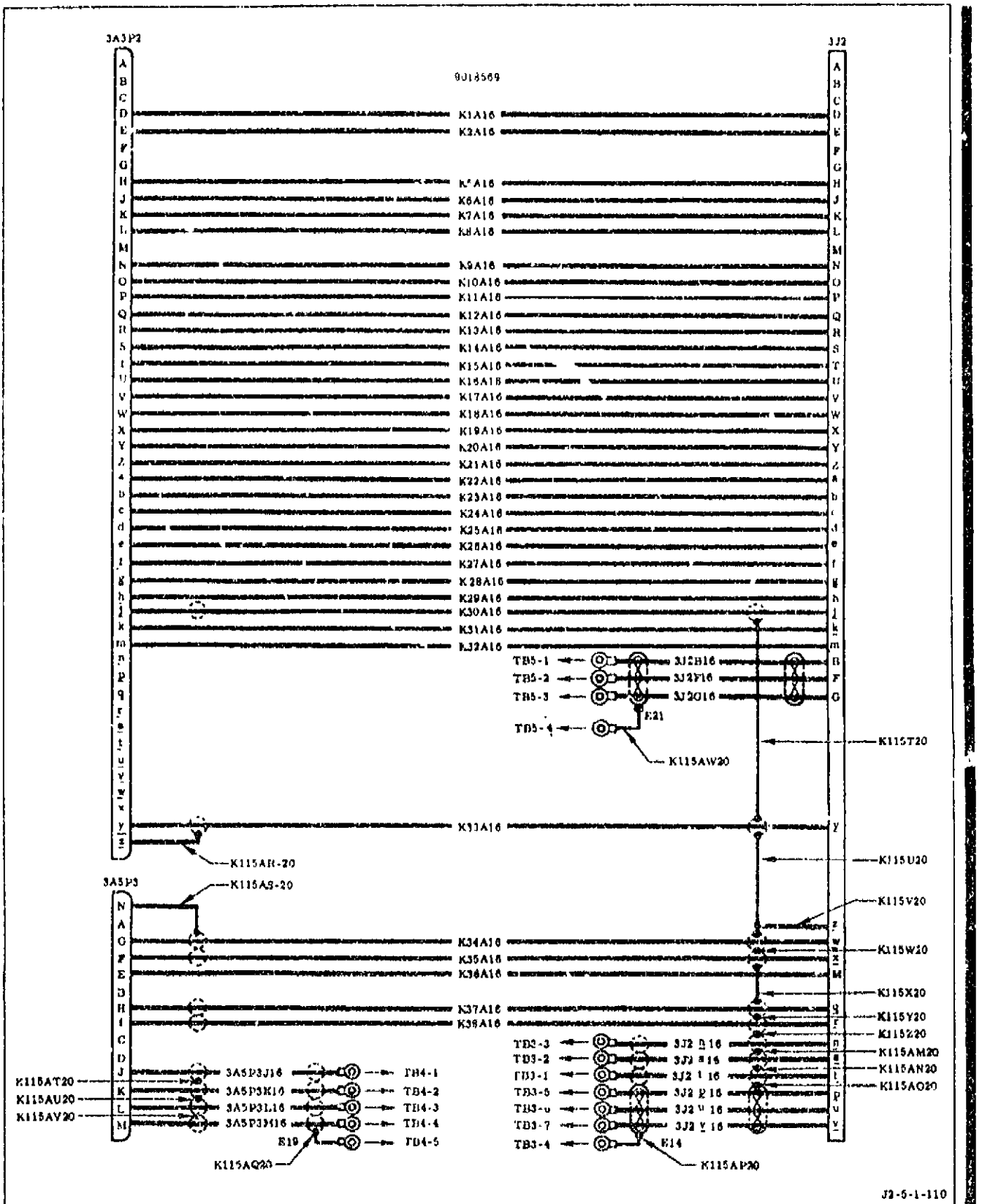


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 1 of 7)

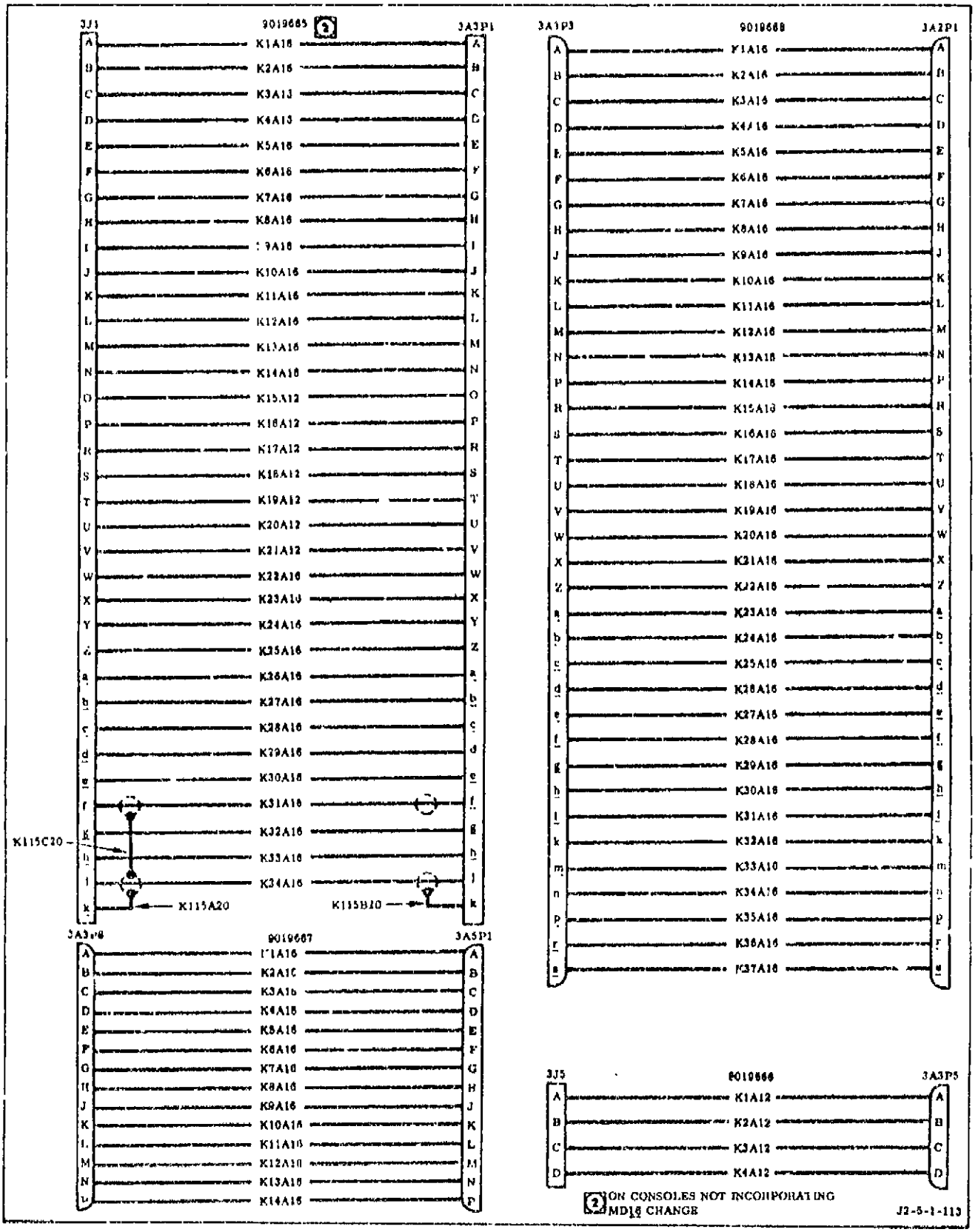


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 2 of 7)

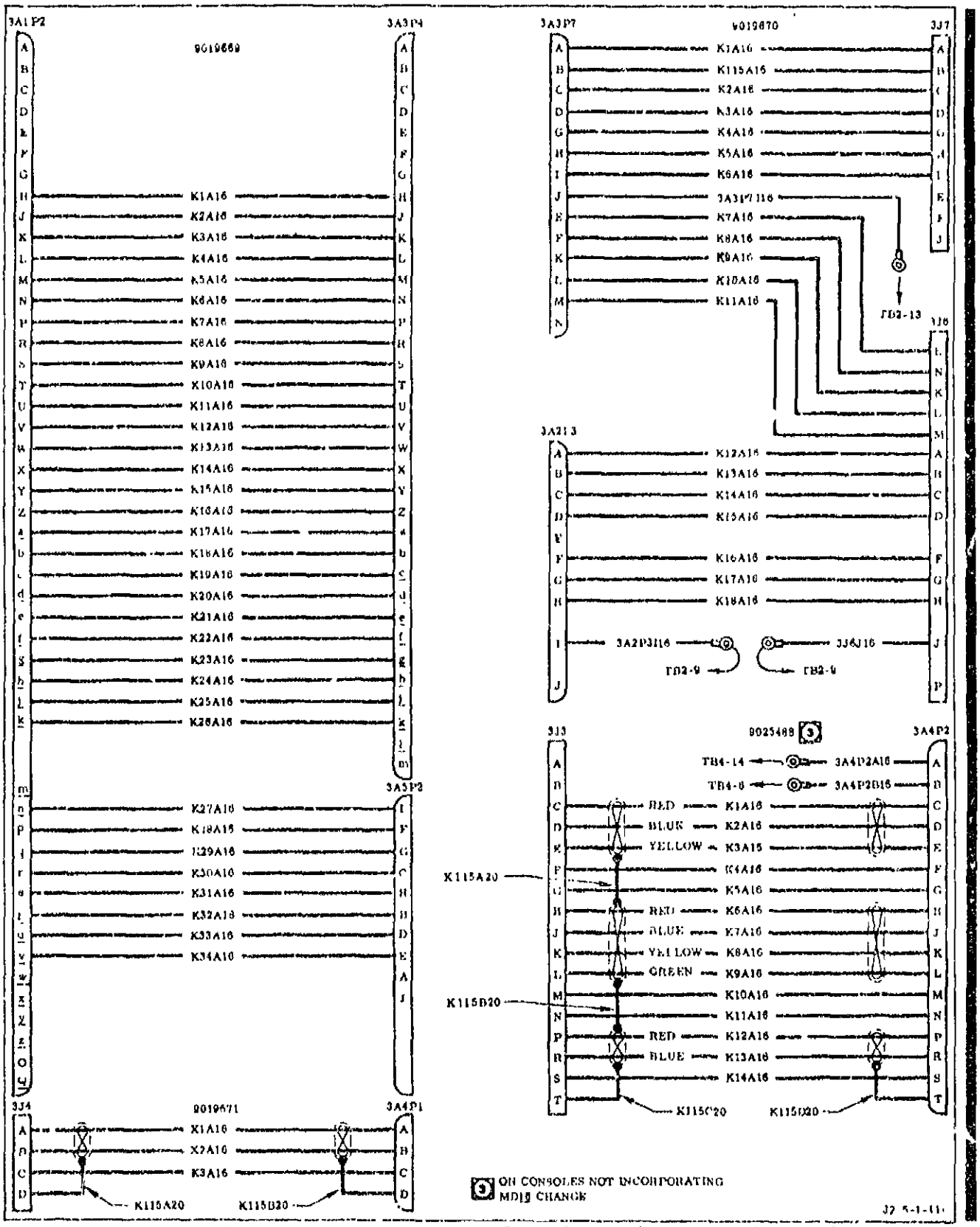


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 3 of 7)

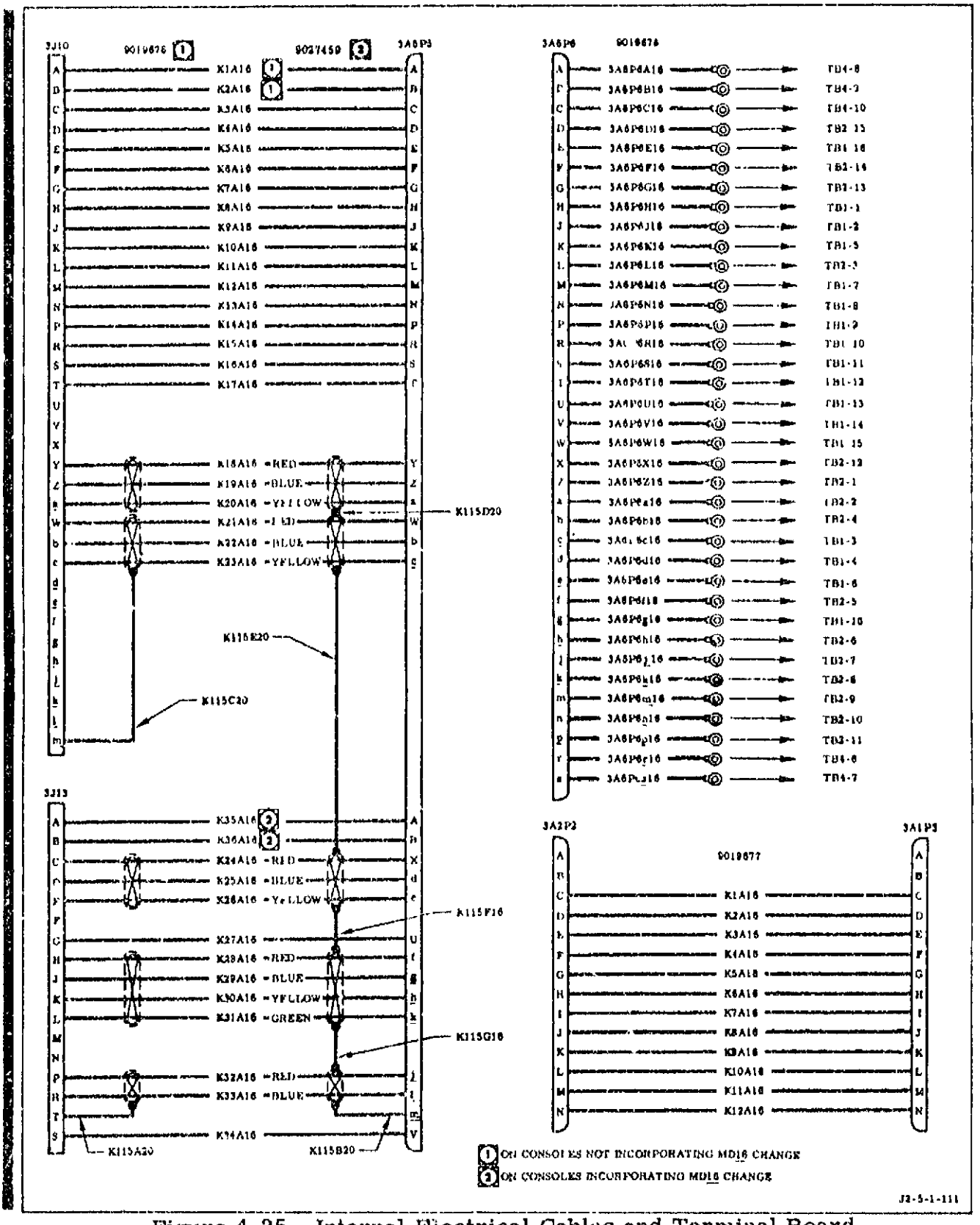


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 4 of 7)

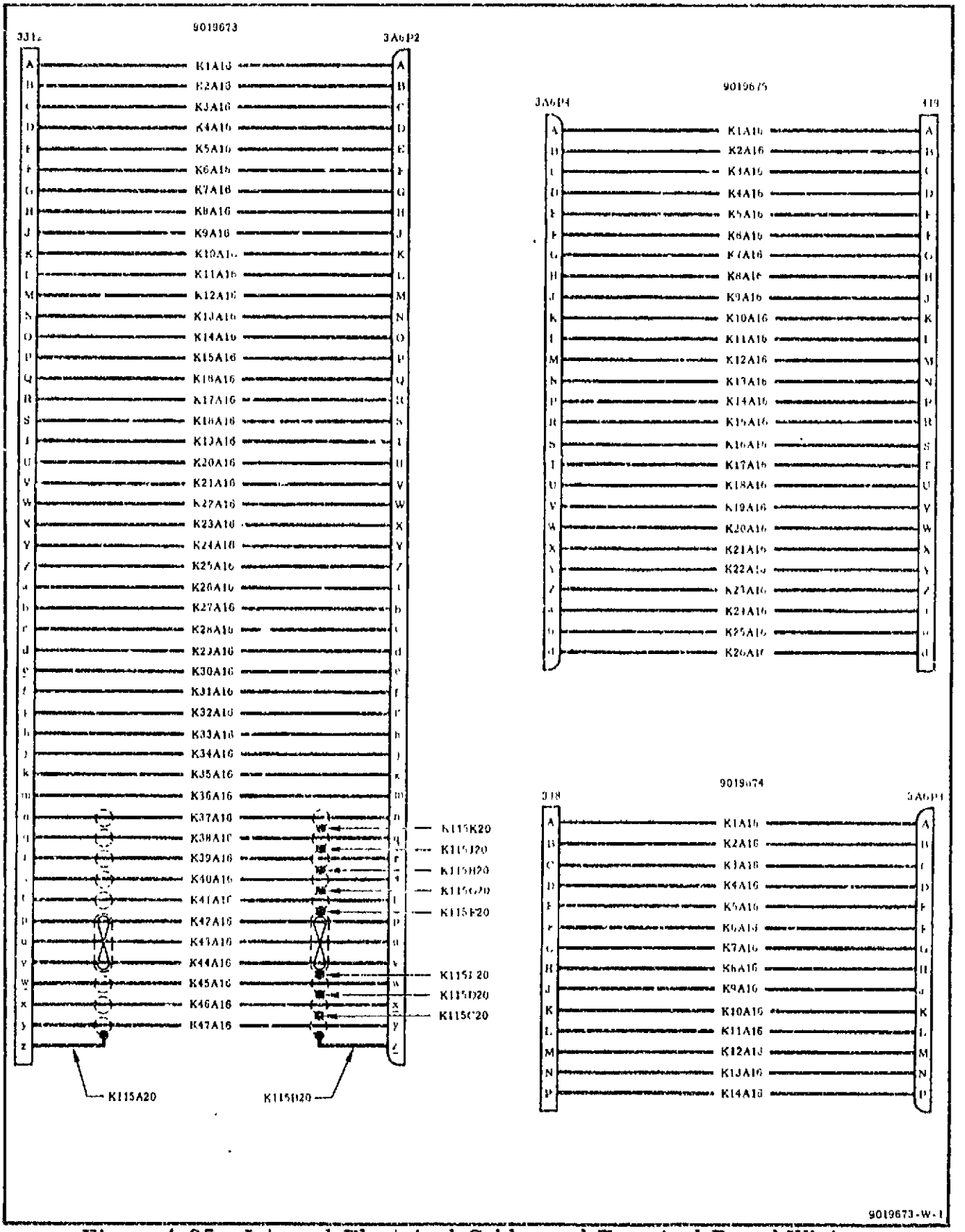


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 5 of 7)

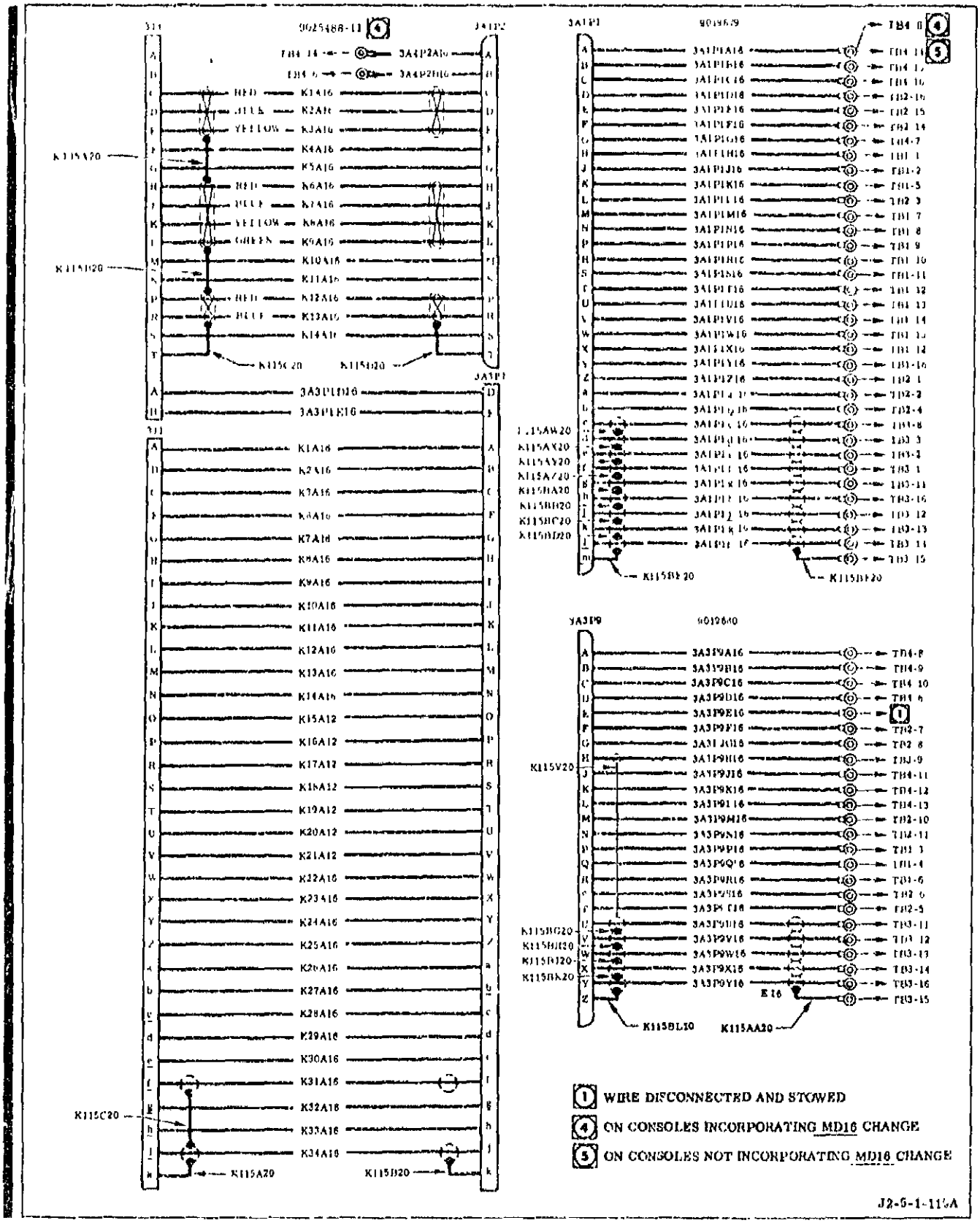

1 WIRE DISCONNECTED AND STOWED
4 ON CONSOLES INCORPORATING MD16 CHANGE
5 ON CONSOLES NOT INCORPORATING MD16 CHANGE
J2-5-1-11%A

Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 6 of 7)

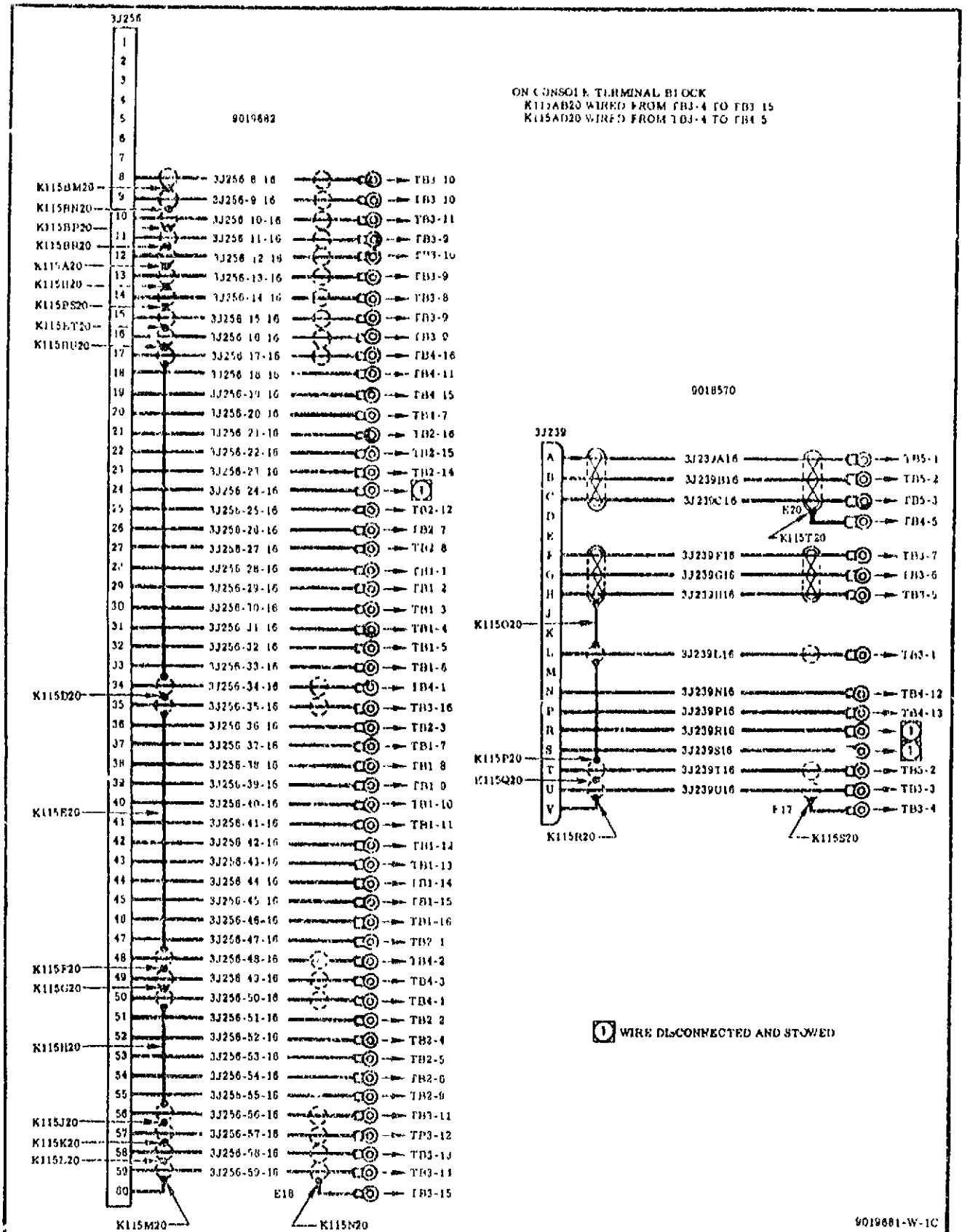
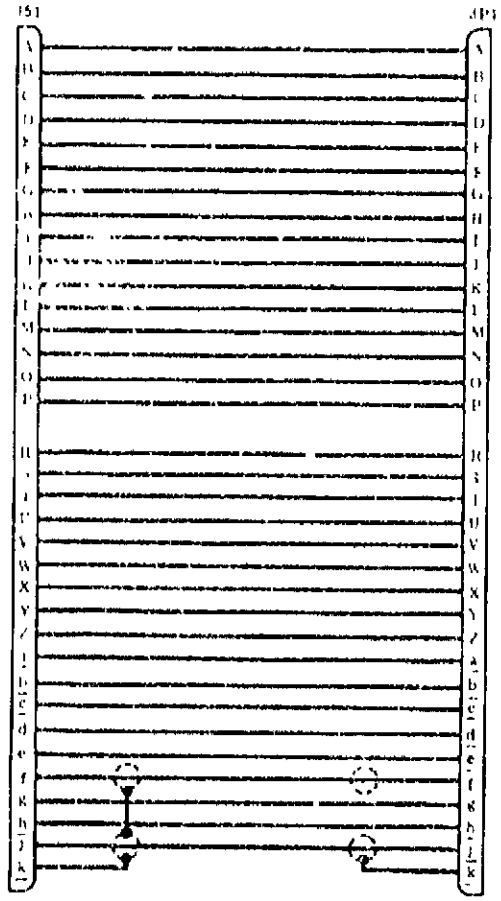


Figure 4-25. Internal Electrical Cables and Terminal Board Wiring Diagram (Sheet 7 of 7)



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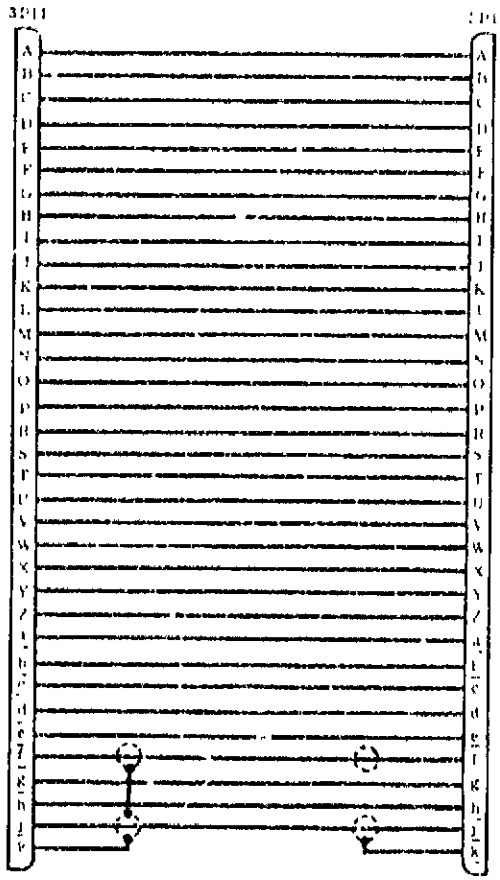

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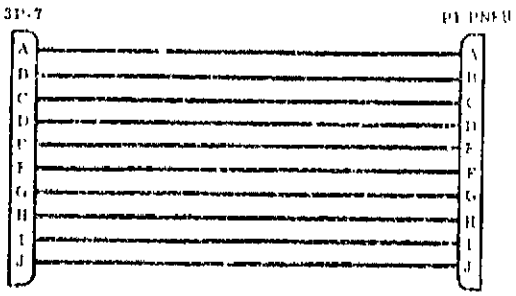

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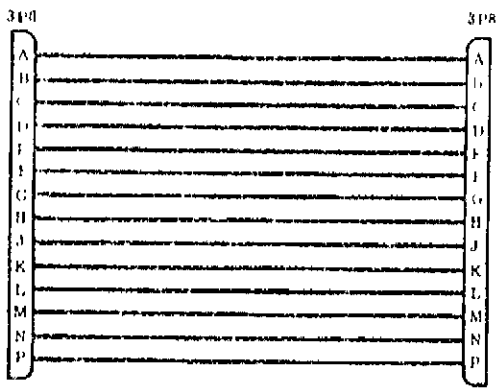

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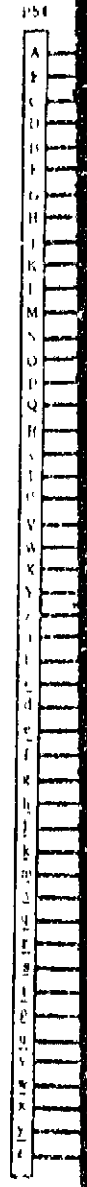
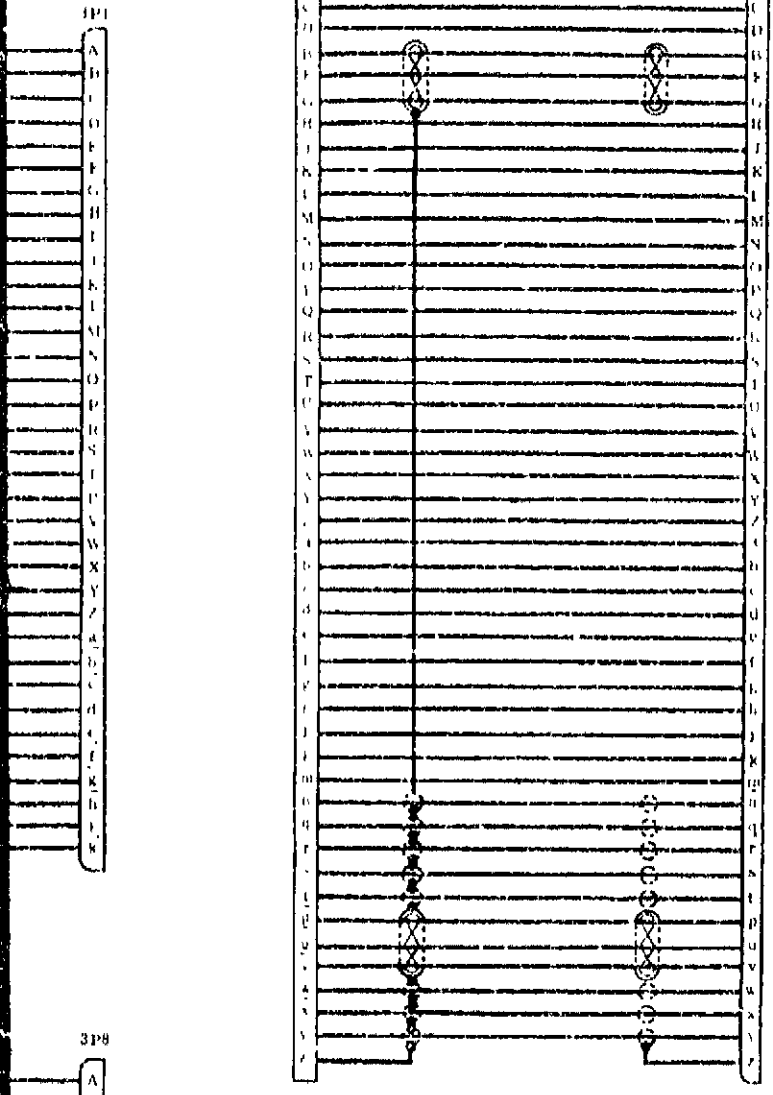


Figure 4-26. External Electrical Cable Wiring Diagrams (Sheet 1 of 3)



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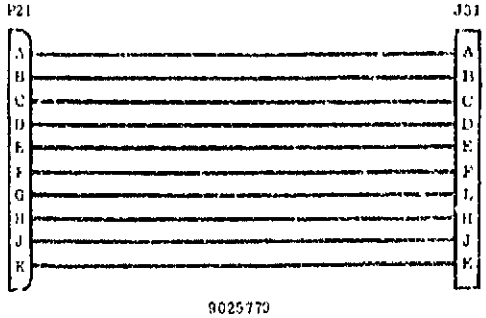
NAS 2709JT P28I



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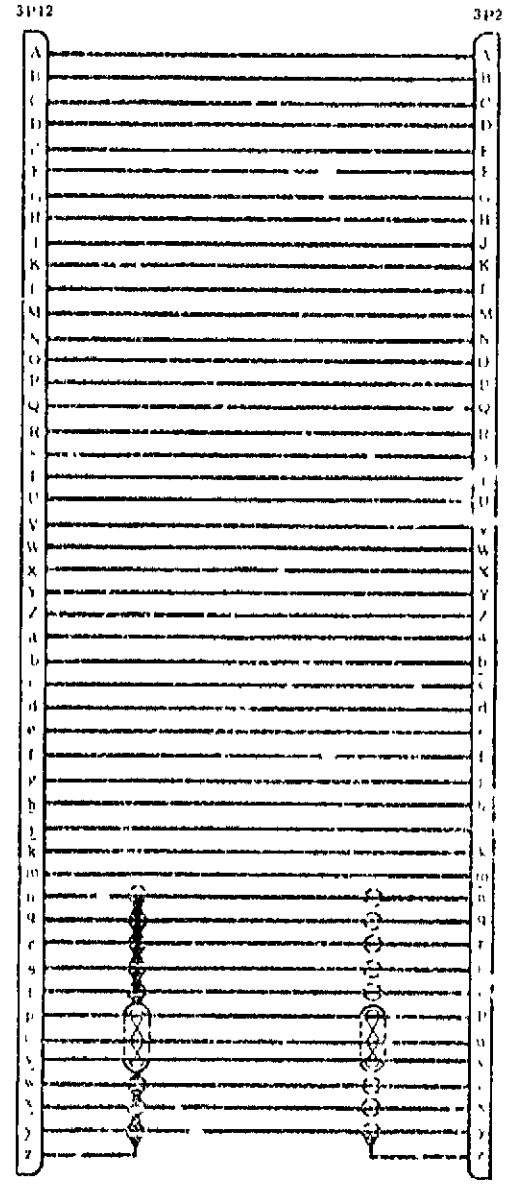

(19-901964
NAS-2709JT P 21

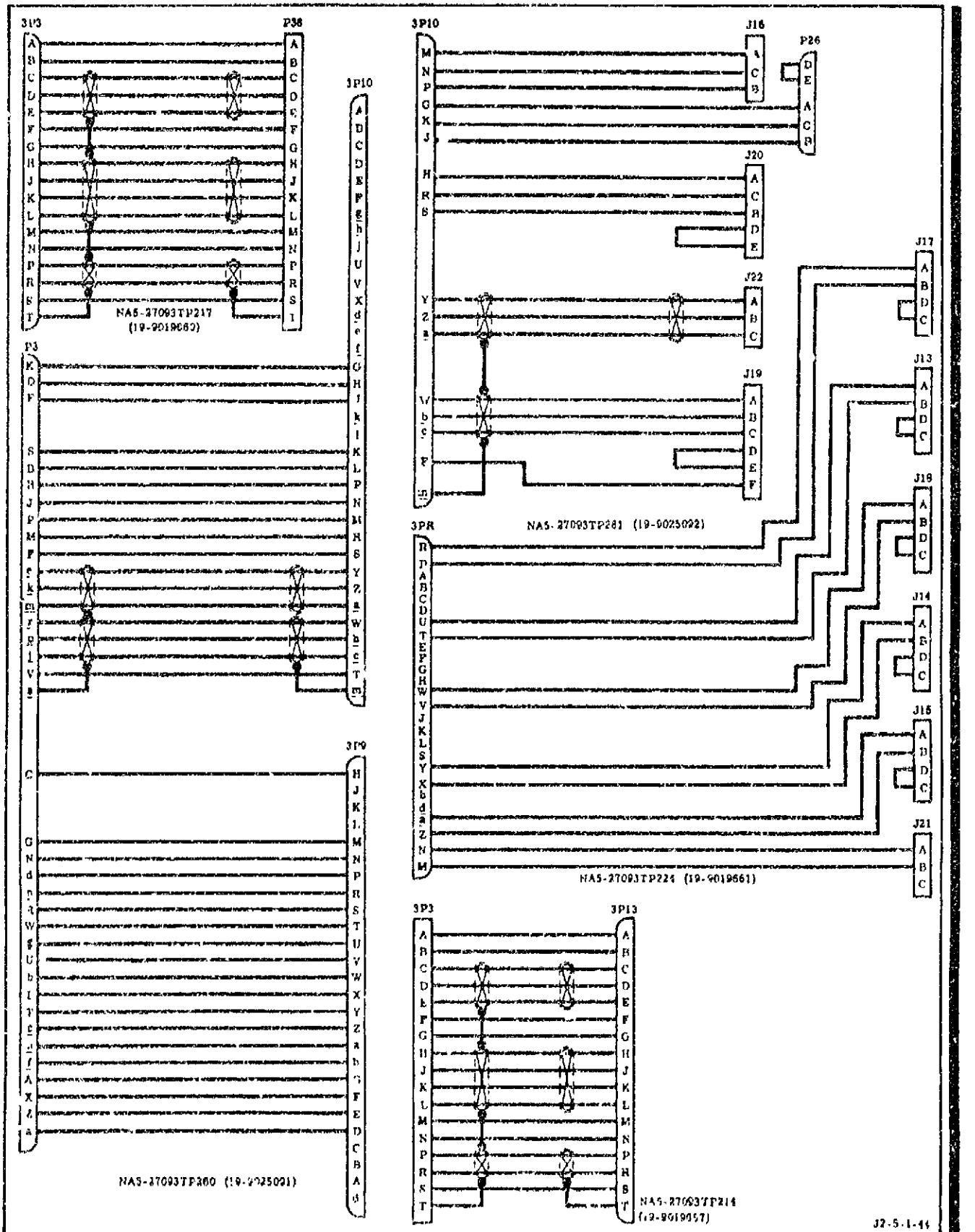

Figure 4-26. External Electrical Cable Wiring Diagrams (Sheet 2 of 3)

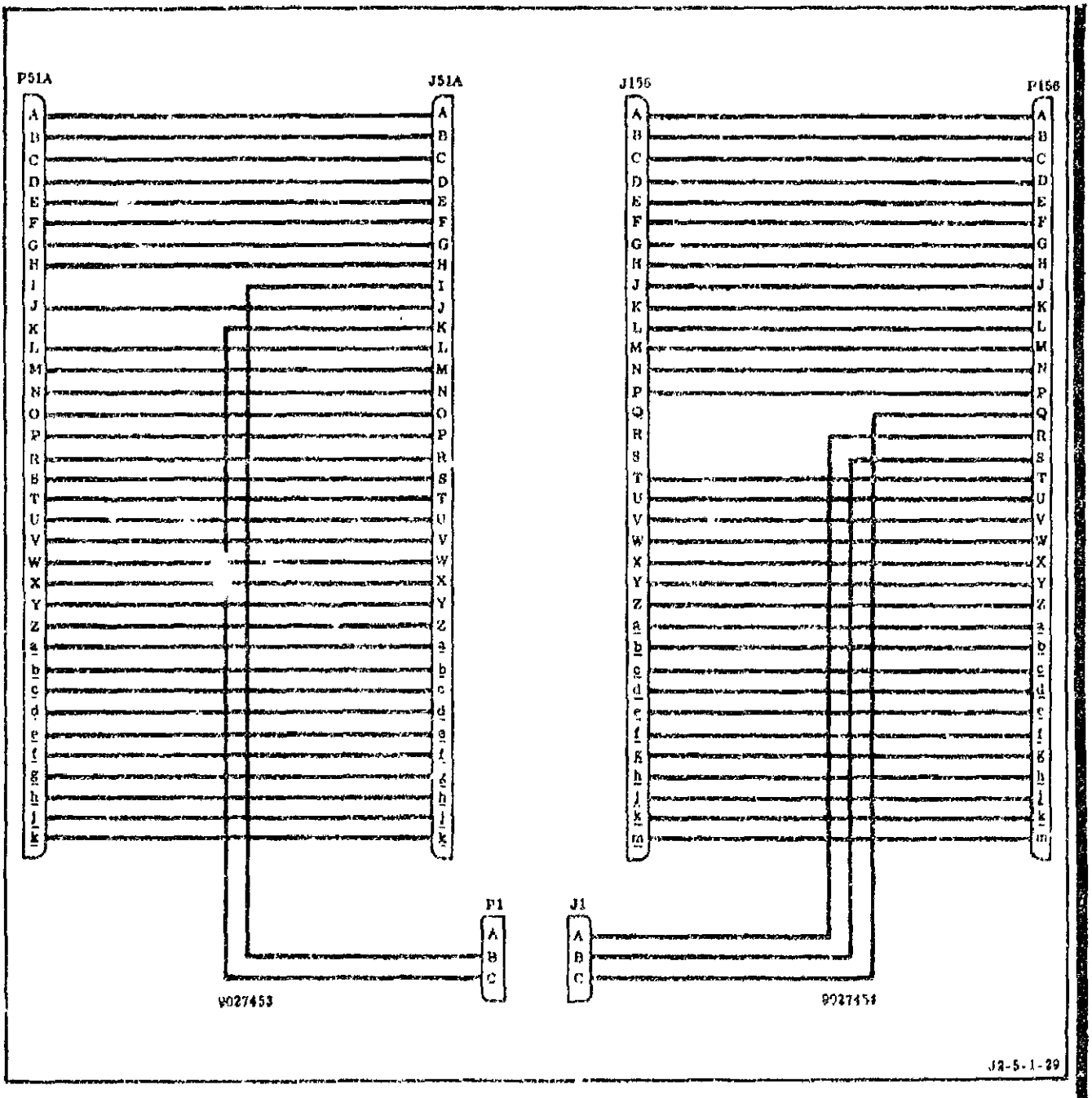

Figure 4-26. External Electrical Cable Wiring Diagrams (Sheet 3 of 3)

Step	Loc	Operation	Loc	Result
NOTE: Whenever this test requires adjusting a potentiometer, loosen locknuts to make adjustments, then retighten sufficiently to prevent inadvertent movement of adjustment screw. Results shall be obtained with locknuts tightened.				
1		Connect self-check cables (figure 4-14). There is no need to connect test cable from J3 to J13 connectors; however, installation of this cable does not adversely affect this test. Connect facility electrical cables and supply power.		
2		If circuit boards are installed in the checkout console, disconnect P3 plug from connector J3 on rear of SPARK MONITOR panel.		
3		Obtain oscilloscope, test cable, counter recorder, and multimeter listed in figure 4-13. Connect test equipment as follows: a. Oscilloscope, counter recorder, and multimeter to SIMULATOR panel SPARK EXCITER MONITOR TEST SIMULATOR OUTPUT jacks. Connect negative test leads of the 3 instruments to COM jack. b. Circuit board to be tested to SIMULATOR panel SPARK EXCITER MONITOR TEST BOARD TEST connector with test cable.		
CAUTION: Lay circuit board on an insulated surface to prevent a short circuit and possible damage to equipment.				
4	GR	Depress 28 VDC POWER circuit breaker.		No visible results.
5	EC	Depress ENGINE POWER circuit breaker.	S	8 light on.
6	EC	Move switch immediately below ENGINE GROUND POWER light to ON.	EC	ENGINE GROUND POWER light on. MAINSTAGE OK NO. 1 DEPRESSURIZED light on. MAINSTAGE OK NO. 2 DEPRESSURIZED light on.

Figure 4-27. Function-Testing Spark Exciter Monitor Circuit Boards (Sheet 1 of 4)

Step	Loc	Operation	Loc	Result
				ENGINE BUS VOLTAGE meter indicates 24-30 vdc.
			ETM	START TANK DEPRESSURIZED light on.
				IGNITION BUS ARMED light on.
			S	FLIGHT INST. DE-ENERGIZE light on.
				19, 28, 32, and 33 lights on.
7	EC	Move BUS SELECT switch to CONTROL.		No visible results.
8	S	Move FACILITY READY switch to READY.	EC	FACILITY READY light on.
9	GR	Move TEST/FIRE SELECT switch to OK TO TEST.		No visible results.
10	EC	Depress TEST POWER circuit breaker.	EC	TEST light on.
11	S	Move SIMULATOR switch to ON.	TE	Multimeter indicates 6.0 ±0.3 volts.
				Oscilloscope indicates a 1-2 volt pulse.
				Counter recorder indicates 33 ±1 pulses.
NOTE:		If results of step 11 are not obtained, perform steps 12 through 14. If results of step 11 are obtained, proceed directly to step 15.		
12	S	Adjust DC LEVEL potentiometer until multimeter indicates 6.0 ±0.3 volts.		
13	S	Adjust PULSE AMPLITUDE potentiometer until oscilloscope indicates a 1-2 volt pulse.		

Figure 4-27. Function-Testing Spark Exciter Monitor Circuit Boards (Sheet 2 of 4)

Step	Loc	Operation	Loc	Result
14	S	Adjust PULSE RATE potentiometer until counter recorder indicates 33 ±1 pulses per second.		
15	S	Remove oscilloscope positive test lead from SPARK EXCITER MONITOR TEST SIMULATOR OUTPUT and connect it to R19 (opposite side of resistor from reference designation R19) on spark exciter monitor circuit board. Remove multimeter positive test lead from SPARK EXCITER MONITOR TEST SIMULATOR OUTPUT jack on SIMULATOR panel and connect it to +C2 on spark exciter monitor circuit board.		
NOTE:		It may be necessary to remove varnish from component leads to establish positive electrical contact.		
16		Adjust potentiometer R2 clockwise on spark exciter monitor circuit board until a minimum of +20 vdc appears on the multimeter. Readjust potentiometer R2 counterclockwise until +20 vdc disappears on multimeter. Slowly readjust potentiometer R2 clockwise until +20 vdc minimum just appears on multimeter, and do not readjust potentiometer in either direction.		
17		Adjust potentiometer R16 clockwise on spark exciter monitor circuit board until pulse appears on the oscilloscope; then readjust potentiometer counterclockwise until pulse just disappears.		
18	S	Disconnect test leads from circuit board and reconnect test equipment (oscilloscope, counter recorder, and multimeter) so that the following test leads are connected: a. Negative leads of all the test instruments to SPARK EXCITER MONITOR TEST SIMULATOR OUTPUT COMM jack. b. Positive lead of oscilloscope TRIGGER INPUT to SPARK EXCITER MONITOR TEST SIMULATOR OUTPUT red jack. c. Positive lead of multimeter to SPARK EXCITER MONITOR TEST BOARD TEST 24-32 V jack. d. Positive leads of oscilloscope and counter recorder to SPARK EXCITER MONITOR TEST BOARD TEST 0-10 V jack.		
19		Set oscilloscope as follows: a. SENSITIVITY to 5 volts per centimeter. b. SWEEP SPEED to 0.1 second per centimeter. c. TRIGGER MODE switch to H. F. SYNC. d. TRIGGER SLOPE to EXTERNAL POSITIVE.		

Figure 4-27. Function-Testing Spark Exciter Monitor Circuit Boards (Sheet 3 of 4)

Step	Loc	Operation	Loc	Result
20		Adjust PULSE RATE potentiometer to increase in increments of one pulse per second. After each pulse increase momentarily actuate RESET switch until multimeter indicates 24-32 vdc within 500 ±300 milliseconds, as indicated on the oscilloscope.		Counter recorder indicates 36-41 pulses per second.
NOTE:		If results of step 20 are not obtained, repeat steps 16 through 20.		
21	S	Move SIMULATOR switch to OFF.		Indications disappear from oscilloscope, counter recorder, and multimeter.
22	S	Move SIMULATOR switch to ON.		Oscilloscope indicates 36-41 pulses per second, with amplitude of 5-10 volts per pulse.
NOTE:		Oscilloscope indicates 24-28 milliseconds per pulse.		
23	S	Move SIMULATOR switch to OFF.		Indications disappear from oscilloscope, counter recorder, and multimeter.
24		Disconnect test equipment.		

Figure 4-27. Function-Testing Spark Exciter Monitor Circuit Boards
(Sheet 4 of 4)

4-28. CALIBRATION REQUIREMENTS FOR ELECTRICAL CHECKOUT CONSOLE INSTRUMENTS.

4-29. The engine control panel voltmeter and propellant valve opening meter shall be checked to ensure an accuracy of 2 percent of full scale. The propellant valve opening METER CALIBRATE switch shall be in CALIBRATE position and 25 vdc applied to test jacks. Perform a 5-step calibration of 20 percent (5 vdc) for each step. Twenty-five vdc is 100 percent of scale. When calibrating the voltmeter, ensure that cable assemblies are disconnected from the console interface to prevent 50 vdc from being applied to the engine control bus.

4-30. MAINTENANCE OF ELECTRICAL CHECKOUT CONSOLE COMPONENTS.

4-31. Maintenance of components consists of removing, installing, testing, and calibrating. The console is function-tested after component installation or calibration (paragraph 4-25). See figures 4-14 and 4-19 through 4-27 for installation of electrical cables.

4-32. REMOVING AND INSTALLING COMPONENTS.

4-33. PANELS.

a. Open rear access door or remove panels below ENGINE TEST/MONITOR and ENGINE CONTROL panels.

b. Disconnect electrical connectors and ground wire from panel to be removed.

c. Remove retaining screws from front of console panel and slide panel from console.

d. Install panel in reverse order of removal. Torque screw securing panel to 38-46 inch-pounds and nuts securing ground wires to 8-10 inch-pounds.

4-34. CIRCUIT BOARDS.

a. Remove SPARK MONITOR panel as outlined in paragraph 4-33.

b. Remove spark exciter monitor from SPARK MONITOR panel, then remove cover and plate from spark exciter monitor.

CAUTION

Screws securing the cover and plate are Torq-Set types and require special screwdrivers. Use of a different screwdriver may damage the screw.

c. Remove circuit board by pulling straight out. There is no need to disconnect electrical connector from circuit board.

NOTE

The 4 identical circuit boards are connected as follows: NO. 1 ASI SPARK to P1, NO. 2 ASI SPARK to P2, NO. 1 GG SPARK to P3, and NO. 2 GG SPARK to P4.

d. Reinstall in reverse order of removal. Torque screws securing plate to 16-20 inch-pounds, screws securing cover to 133-163 inch-ounces, and screws securing spark exciter monitor to SPARK MONITOR panel to 9-11 inch-pounds.

4-35. TESTING COMPONENTS.

4-36. SPARK EXCITER MONITOR CIRCUIT BOARDS. Two procedures can be used to test the circuit boards. One procedure, using the spark monitor turbine overspeed cutoff test set 9024499-21, is in R-3825-5, Volume II. The other procedure uses Electrical Checkout Console G1037 incorporating MD10 change. To test a circuit board using the checkout console, see figure 4-27.

4-37. CALIBRATING COMPONENTS.

4-38. ADJUSTING TIME DELAY RELAY.

a. Remove applicable panel from console. Refer to paragraph 4-33.

b. Obtain the following test equipment:

(1) Millisecond timer, MST500-4-6 (Standard Electric Time Co), or equivalent.

(2) Regulated power supply, 0-50 vdc.

c. Connect timer leads to relay terminals 7 and 8.

d. Energize relay with 28 vdc. Terminals 1 and 6 are positive; 8 negative. See figure 4-28 for relay designation and timing requirements.

e. To increase relay timer, turn adjustment screw clockwise.

Relay Designation and Type [a]	Relay Timing in Seconds
Ground Relay Panel	
K11 (pickup)	1.0 ±0.10
K12 (dropout)	1.5 ±0.15
K15 (pickup)	0.5 ±0.50
K16 (dropout)	180.0 ±18.0
K23 (pickup)	0.5 ±0.05
Simulator Panel	
K4 (pickup)	1.0 ±0.10
K7 (pickup)	0.5 ±0.05
K11 (pickup)	0.55 ±0.05
K13B (pickup)	0.7 ±0.07
K14 (pickup)	3.0 ±0.30

(a) Terminal 7 is normally closed on dropout, and normally open on pickup relays.

Figure 4-28. Time Delay Relay Timing

SECTION V

FLIGHT INSTRUMENTATION CHECKOUT CONSOLE G1035

WARNING

FLIGHT INSTRUMENTATION CHECKOUT CONSOLE G1035 AND DATA RECORDER CONSOLE G3121 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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5-1. DESCRIPTION AND LEADING PARTICULARS FOR FLIGHT INSTRUMENTATION CHECKOUT CONSOLE.

5-2. The flight instrumentation checkout console (figure 5-1) performs calibration checks of the engine flight instrumentation system to ensure engine instrumentation acceptability. The console consists of two cabinets mounted on a base, one containing the electrical panels and one providing a storage area. Incorporated in the console base are provisions for handling the console with a forklift. Access doors are provided on the front of the storage cabinet and the rear of each

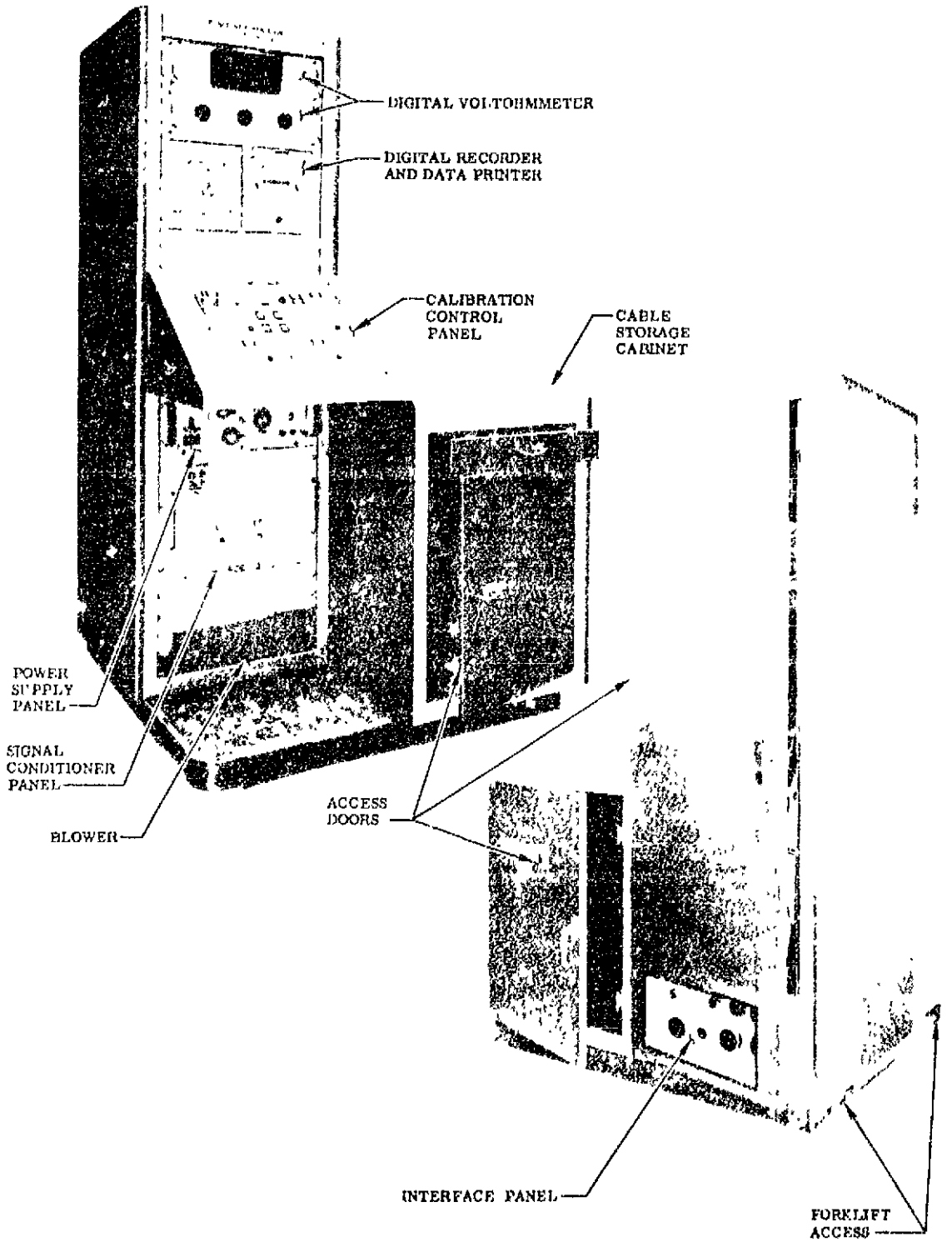


Figure 5-1. Flight Instrumentation Checkout Console

cabinet. The standard 19-inch electrical panels consists of a blower, power supply, calibration control, signal conditioner, digital voltohmmeter, data printer panels on the console face, and an electrical interface panel in the rear. A plug mold bus strip mounted in the console contains receptacles to provide power for the digital voltohmmeter, digital recorder, and blower. The blower circulates cooling air throughout the console. Internal cables interconnect the electrical panels. External electrical cables interconnect the associated ground support equipment and the engine, and are stored in the console storage cabinet. See figure 5-2 for leading particulars of the console. Instructions for the use of the console are in Technical Manuals R-3825-3, Volume I, and R-3825-2.

Dimensions	
Height	78.5 inches
Width	45.0 inches
Depth	26.0 inches
Storage Cabinet Height	36.0 inches
Weight	550 pounds
Power Requirements	115 ±5 vac, single-phase 60-cycle, 15-ampere.
Panels	Standard 19-inch.

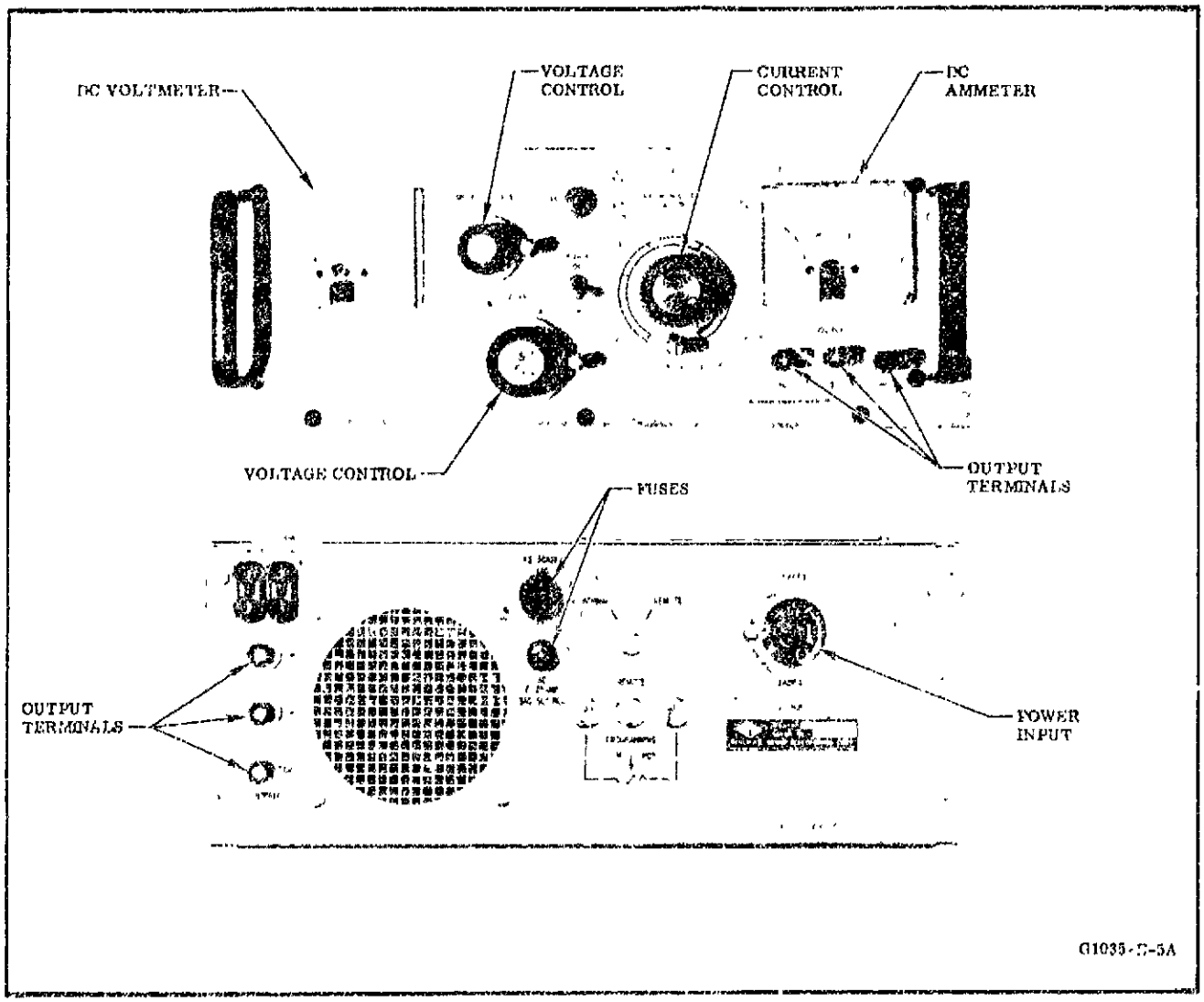
Figure 5-2. Leading Particulars for Flight Instrumentation Checkout Console

5-3. POWER SUPPLY PANEL.

5-4. The power supply panel (figure 5-3) provides a regulated source of 28-vdc power to the calibration control panel, signal conditioner panel, and engine instruments. The solid-state power supply utilizes facility-supplied 115-vac power to provide the 28-vdc power. The panel contains voltage and current controls and meters. Voltage controls are provided for both coarse and fine adjustments.

5-5. CALIBRATION CONTROL PANEL.

5-6. Calibration control panel 9025079 and 9025102-21 (figure 5-4) provide the necessary circuitry to select the calibration test to be performed through the data entry modes. The panel is slope-mounted on the console and contains a timer



Dimensions: 19 x 7 inches, approximately

Weight: 100 pounds

Power input: 115-vac, single-phase, 60-cycle, 25-ampere

Power output: 0-36 vdc, 30-ampere

Figure 5-3. Power Supply Panel

P308-5 Power supply West Arco Inc LA. Calif

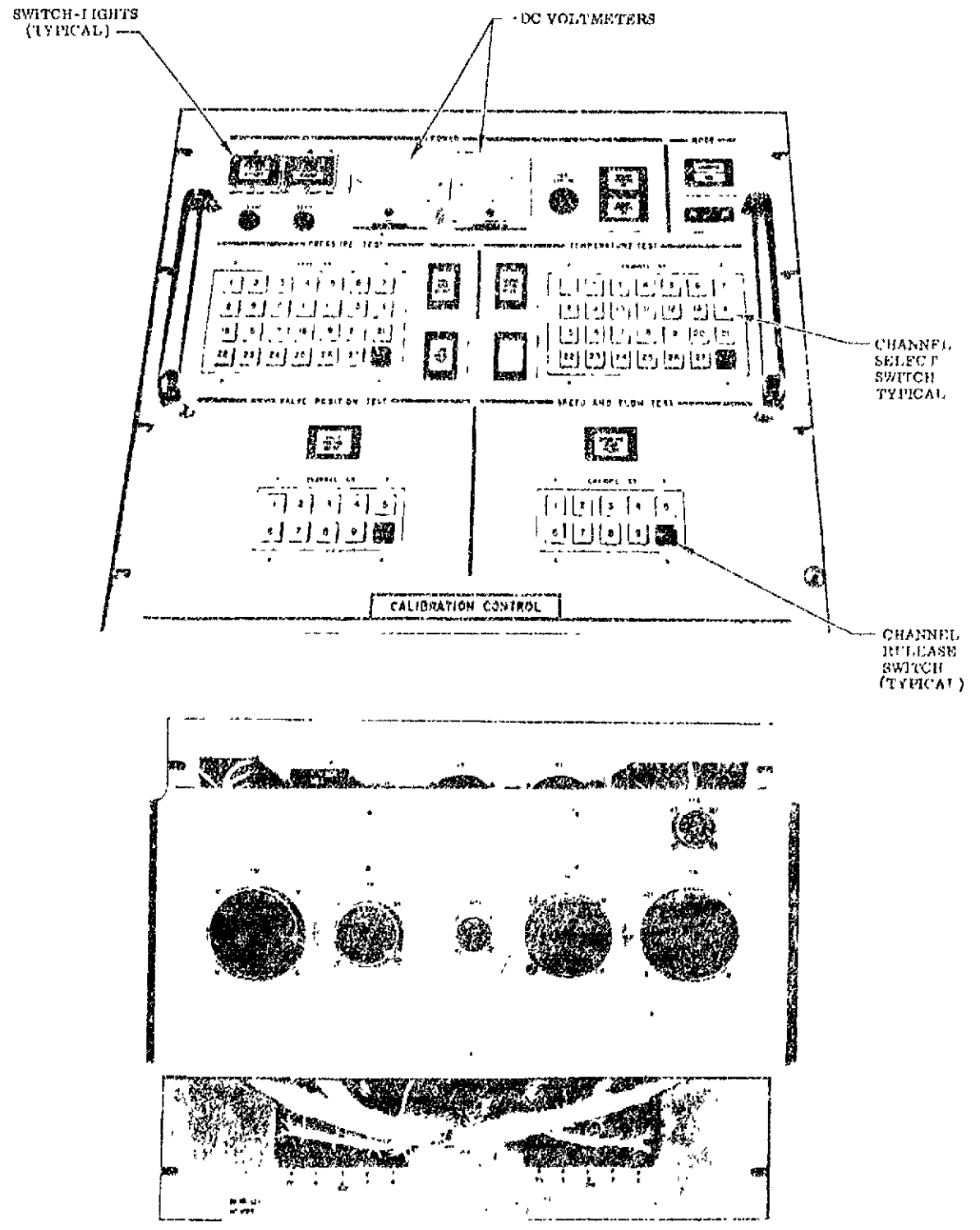


Figure 5-4. Calibration Control Panel

gate circuit, terminal boards, signal-switching modes and interconnecting circuitry. The panel has a five-ampere rating and weighs 15 pounds. The face of the panel is divided into six sections: POWER, MODE, PRESSURE TEST, TEMPERATURE TEST, VALVE POSITION TEST, and SPEED AND FLOW TEST.

5-7. The POWER section consists of a 115-vac and 28-vdc circuit breaker, two power indicating switch-lights, two voltmeters, a test light switch, and two heater control switch-lights. The power section controls and monitors voltage distribution throughout the console.

5-8. The MODE section consists of a mode-selector switch-light and a mode-reset locked-in light. The mode-selector arms the calibration panel, allowing checkout from this panel only. The mode-reset locked-in light comes on if a signal from another source has been initiated, indicating that the calibration panel is bypassed and is in a standby condition, only when the calibrate mode has been selected

5-9. The PRESSURE TEST section and the TEMPERATURE TEST section consist of pressure select and temperature select switch-lights, high- and low-calibration test switch-lights, and a 27-channel switch-light keyboard with a master release switch. These sections select the type of parameters to be checked, the individual parameter, and the level of calibration.

5-10. The VALVE POSITION TEST section consists of a valve position select switch-light and a 9-channel switch-light keyboard with a master release switch. This section selects any one of six valve-position potentiometers and provides a connection to the digital voltohmmeter from the wiper at the valve potentiometer.

5-11. The SPEED AND FLOW TEST section consists of a speed and flow select switch-light and a 9-channel select switch keyboard with a master release switch. This section selects the proper transducer and induces a set frequency to the transducer coil to simulate pump speed or propellant flowrate.

5-12. DIGITAL VOLTOHMMETER.

5-13. The digital voltohmmeter (figure 5-5) provides a visual display of the analog information obtained from the calibration control panel, and further prepares the output signals for data printout. The voltohmmeter operates on 115-vac power provided from the ac bus strip, and is comprised of two units, a data readout and a control panel. Power selection, function, and mode switches are incorporated on the control panel, and a display instrument on the readout panel. Interconnecting electrical cables are supplied with the units. The voltohmmeter has a range of ±0.001 to 999.9 vdc, a rating of 1.6 amperes, and a weight of 70 pounds. Complete information can be obtained from the Operation and Service Manual for NLS Model M24 (Non-Linear Systems, Inc) included with the flight instrumentation checkout console.

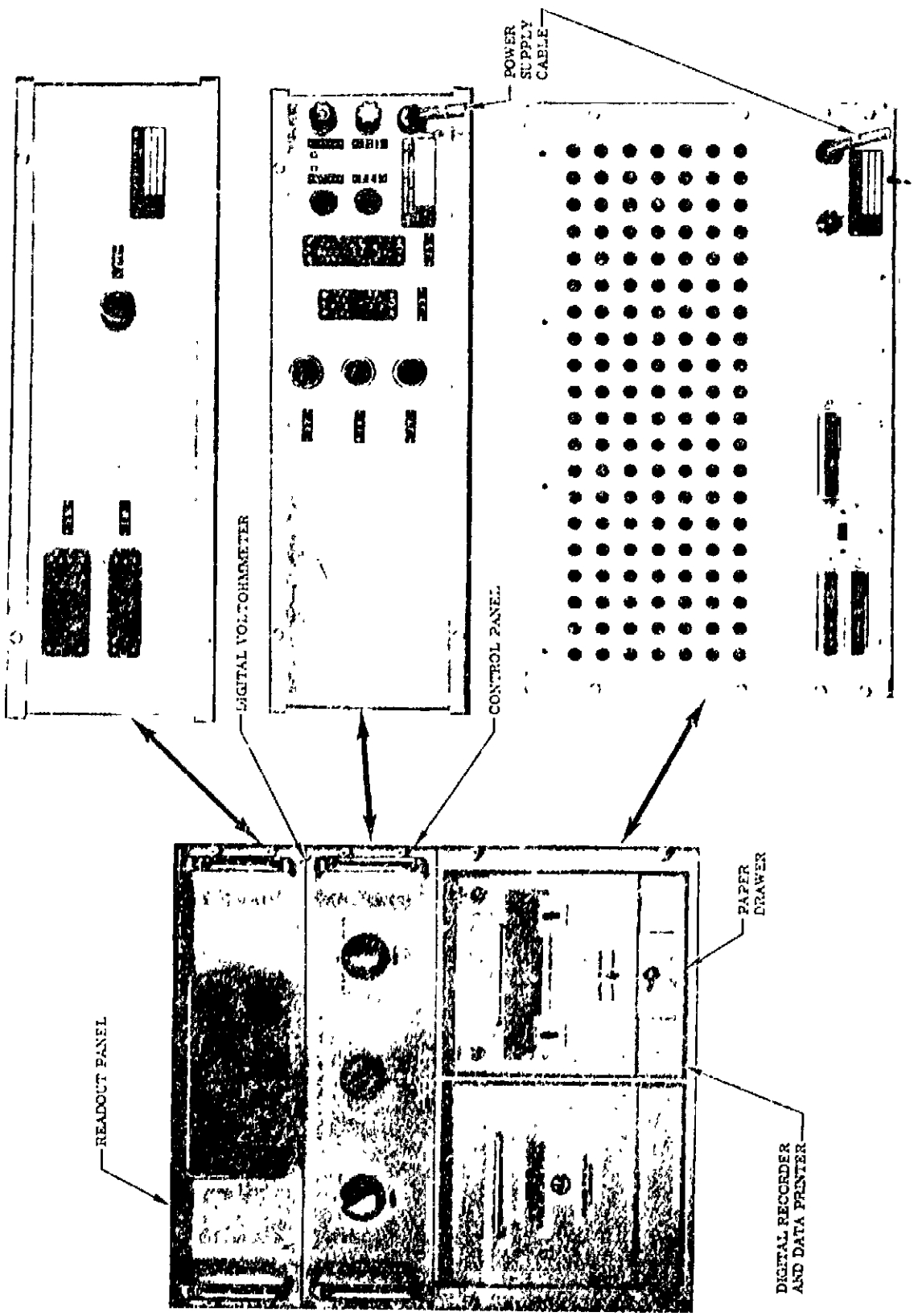


Figure 5-5. Digital Voltohmmeter and Digital Recorder

5-14. DIGITAL RECORDER.

5-15. The digital recorder (figure 5-5) prints data received from the digital volt-ohmmeter. The recorder operates on 115-vac power provided from the bus strip. Information can be obtained from the Operation and Service Manual for NLS Model 155 Printer (Non-Linear Systems, Inc) included with the flight instrumentation checkout console. An electrical cable interconnects the digital voltohmmeter and the digital recorder.

5-16. SIGNAL CONDITIONER PANEL.

5-17. The signal conditioner panel 9024509-11 and 9025103-41 (figure 5-6) distributes the required test signals to the transducer being tested. Speed and flow and temperature transducer output signals are then conditioned to a recordable level. The signal conditioner panel is track-mounted in the console. Rating is 25 amperes for 28 vdc and 15 amperes for 115 vac. The signal conditioner panel weighs 90 pounds and consists of a signal generator, pulse-rate integrators, amplifiers, circuit boards, circuit breakers, power indicating lights, a 5-vdc power supply, terminal boards, and interconnecting circuitry.

5-18. The signal generator pulse-rate integrator receives the signal supplied from the speed or flow transducer under test. This signal is fed into the pulse-rate integrator, converting it into a 5-vdc output so it can be recorded on the voltohmmeter and digital recorder. The integrator also allows the input signal to pass through a scaler circuit capable of scaling the signal at ratios of 100:1, 10:1, and 1:1, to record the signal on an oscillograph.

5-19. The signal generator is designed to generate five frequency output signals, at 200, 1,692.6, 2,000, 5,300, and 5,500 cps. These signals supply the frequencies necessary to excite the coils of the speed or flow transducer under test, thus simulating a condition at which the transducer is checked. The amplifiers and circuit boards amplify and condition the signal received from the temperature transducer under test. The 5-vdc power supply installed on the front of the panel supplies the low voltage necessary to operate the engine-mounted transducers while under test.

5-20. ACCESSORIES.

5-21. Accessories consist of external interconnecting cables, harness, adapters, and circuit cords. See figure 5-7 for accessories and use.

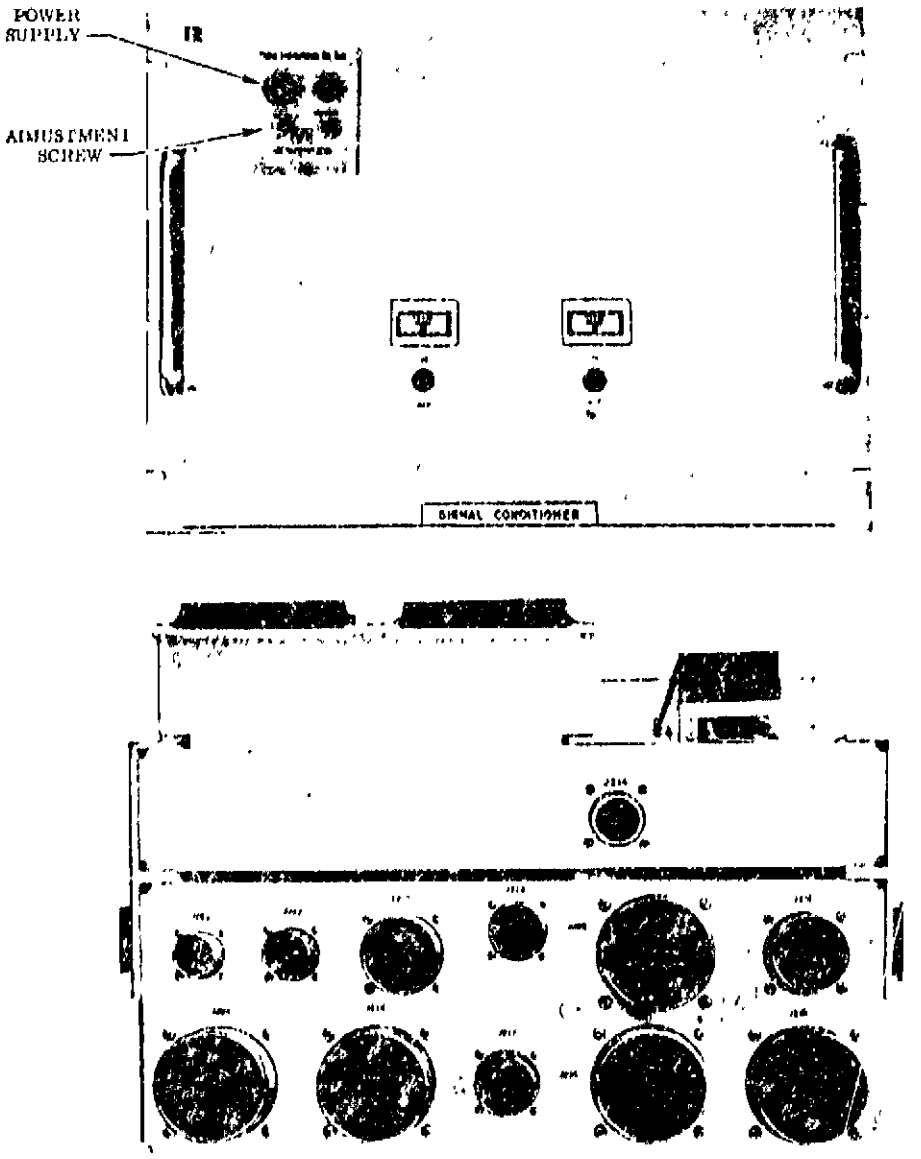


Figure 5-6. Signal Conditioner Panel

Nomenclature	Part Number	Type Number Per NA5-27093	Use
Cable	19-9017533	TP229	Interconnects console and engine interface.
Cable	19-9017534	TP230	Interconnects console and engine interface.
Cable	19-9017535	TP231	Interconnects console and engine interface.
Cable	19-9017536	TP232	Interconnects console and data recorder console.
Cable (a)	19-9019904	TP233	Self-checkout.
Cable (a)	19-9019905	TP234	Self-checkout.
Cable (a)	19-9019906	TP235	Self-checkout.
Cable (a)	19-9019907	TP236	Self-checkout.
Cable (a)	19-9019908	TP237	Self-checkout.
Cable	19-9025058	TP262	Interconnects console and engine interface plugs P108 and P156.
Cable	19-9025059	TP263	Interconnects console and electrical checkout console for engine checkout.
Cable Harness	9025117		Interconnects cable assembly 19-9017533 and engine interface plugs J110A and J111A.
Adapter	9024512 and -11		Adapt cable 19-9017532 to engine interface plugs P103 and P156.

(a) Stored in Data Recorder Console G3121.

Figure 5-7. Flight Instrumentation Checkout Console Accessories (Sheet 1 of 2)

Nomenclature	Part Number	Type Number Per NA5-27093	Use
Adapter	9024512-21		Adapts cable 19-9017533 to engine interface plug P109.
Adapter	9024512-31, -41, and -51		Adapt cable 19-9017534 to engine interface plugs P105, P106, and P107.
Adapter	9024512-61, -71 and -81		Adapt cable 19-9017535 to engine interface plugs P153, P154, and P155.
Circuit Cord (b)	2758-8 or 2631-8		Retained for use in amplifier Z534 for checkout of engines with a 200-300 degree transducer.
Circuit Cord (b)	2958-9		For use in amplifier Z534 for checkout of engines with a 200-500 degree transducer.

(b) Store in shipping container and in console drawer when not installed for engine checkout.

Figure 5-7. Flight Instrumentation Checkout Console Accessories (Sheet 2 of 2)

5-22. THEORY OF OPERATION.

5-23. Facility power is supplied to the power supply panel and the signal conditioner panel. Power is supplied to the digital voltohmmeter and digital recorder by depressing the circuit breaker on the signal conditioner panel. The power supply panel supplies regulated 28 vdc to the power circuit breakers. Depressing the circuit breakers and power switches on the panel energizes the panel circuitry for operation.

5-24. Depressing the mode switch-light to CALIBRATE energizes the circuitry for a desired test. A pressure transducer calibration check is accomplished by depressing the pressure select switch-light, selecting a channel number and the

desired calibration test switch-light, then allowing a signal to be transmitted to the transducer under test. The transducer returns an output signal through the flight instrumentation console circuitry to the digital voltohmmeter and the digital recorder, for display and recording.

5-25. A temperature amplifier calibration check is accomplished in the same manner as the pressure transducer check, except that the TEMPERATURE SELECT switch-light is depressed. The calibration signal from the control panel is sent to the amplifiers in the signal conditioner panel. The amplifiers transmit an output to the digital voltohmmeter and digital recorder for display and recording.

5-26. A valve position check is accomplished by depressing the VALVE POSITION SELECT switch-light, selecting a channel number, and allowing the nominal valve position indicator signal to be transmitted to the digital voltohmmeter and digital recorder for display and recording.

5-27. A speed and flow calibration is accomplished by depressing the SPEED AND FLOW SELECT switch-light and selecting a channel number connecting the signal generator in the signal conditioner panel, to excite the transducer coil with the test frequency. The output signal from the transducer is routed through the pulse-rate integrator, converted to a dc voltage signal, and sent to digital voltohmmeter and digital recorder for display and recording.

5-28. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

5-29. Modifications incorporated changing the configuration of the flight instrumentation checkout console are listed in figure 5-8.

Approved ECP No.	MD NO.	Incorporated in Manual Dated
J2-132	2	14 May 1964
J2-133	1	2 November 1964
J2-143	3	14 May 1964
J2-217	4, 6	21 May 1965
J2-219	4, 5	21 May 1965
J2-267	4, 9	26 January 1965
J2-272	4, 10	21 May 1965
J2-291	4, 8	2 November 1964

Figure 5-8. Configuration Changes--Manual Effectivity.

5-30. To record and identify these modifications, the part number of the affected panel is changed and the configuration of the changed console is identified by a MD number. (For an explanation of the MD numbering system, refer to configuration identification in the Introduction.) To determine the part number of a panel or cabinet required for a console configuration, see figure 5-9. Panels not listed remain unchanged.

	Calibration Control Panel	Signal Conditioner Panel	Cabinet
MD10	9025102-21	9025103-41	9017530-21
MD4	9025079	9024509-11	9017530-21

Figure 5-9. Flight Instrumentation Checkout Console Panel and Cabinet Configurations

5-31. MAINTENANCE REQUIREMENTS FOR FLIGHT INSTRUMENTATION CHECKOUT CONSOLE.

5-32. Maintenance tasks required on the flight instrumentation checkout console are listed in figure 5-10. Information presented outlines the tasks to be performed, when the tasks shall be performed, and reference to data necessary to accomplish these tasks.

5-33. FUNCTION-TESTING.

5-34. Function-testing the console must be performed in the order specified and at an ambient temperature of 75° ±25° F. If results other than those specified occur, the test must be terminated and the defective part repaired or replaced. Personnel must take the necessary safety precautions for electrical equipment during function-testing of the console. See figure 5-11 for console electrical cabling diagram. See figure 5-12 for function-testing procedures, figure 5-13 for remote print command gate circuit test setup, figure 5-14 for an example and explanation of digital recorder printouts, and figure 5-17 for console electrical schematic.

5-35. The function-test procedures include a complete test and an abbreviated test. A complete test is accomplished by performing all steps in the procedure. An abbreviated test is accomplished by omitting steps preceded by an asterisk.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect console for completeness.	X	X			Refer to paragraph 5-20 for accessories for console.
Inspect electrical cables and internal wire harnesses for: Broken or frayed insulation. Damaged connectors.	X	X			Replace cable or harness. See figures 5-20 and 5-21.
Paint calibration control and signal conditioner panel.				X	When damaged, paint surfaces with enamel (Federal Specification TT-E-529); color 25440 (Federal Standard 595).
Paint cabinet.				X	When damaged, paint surfaces with air-dry enamel; light gray ALG and dark gray ADG, (Stantron), as applicable.
Install protective caps on external electrical connectors and receptacles.				X	Whenever connector or receptacle is not in use.
Function-test console.				X	Every 6 months. Refer to paragraph 5-33 and perform abbreviated test if console has not been repaired, modified, or moved. Function-test completely every 2 years minimum or after repairing, modifying, or moving console.
Test temperature-test circuit.				X	Whenever temperature parameters fail to meet engine checkout specifications. Refer to paragraph 5-36.

Figure 5-10. Maintenance Requirements for Flight Instrumentation Checkout Console (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Continuity-test external checkout cables.				X	Every 6 months. See figure 5-20.
Check accuracy of digital voltmeter.				X	Every 6 months. Refer to paragraph 5-38.
Calibrate console instruments.				X	Every 6 months. Refer to paragraph 5-38.
Clean console interior and exterior surfaces and external electrical cables.				X	As required to maintain cleanness. Refer to cleaning in section I.
Clean electrical panels.				X	As required to maintain cleanness of electrical circuitry. Frequency of cleaning depends on environment in which console is used. Refer to paragraph 5-48.
Clean blower filter.				X	Every 90 days. Refer to paragraph 5-47.
Clean signal conditioner amplifier connector ribbon contacts.				X	Every 90 days. Refer to paragraph 5-48.
Lubricate data printer.				X	Every 60 days. Refer to Operation and Service manual for NLS Model 155 Printer (Non-Linear Systems Inc.)
Prepare console for storage.				X	Whenever console is not in use. Refer to paragraph 5-40.

Figure 5-10. Maintenance Requirements for Flight Instrumentation Checkout Console (Sheet 2 of 2)

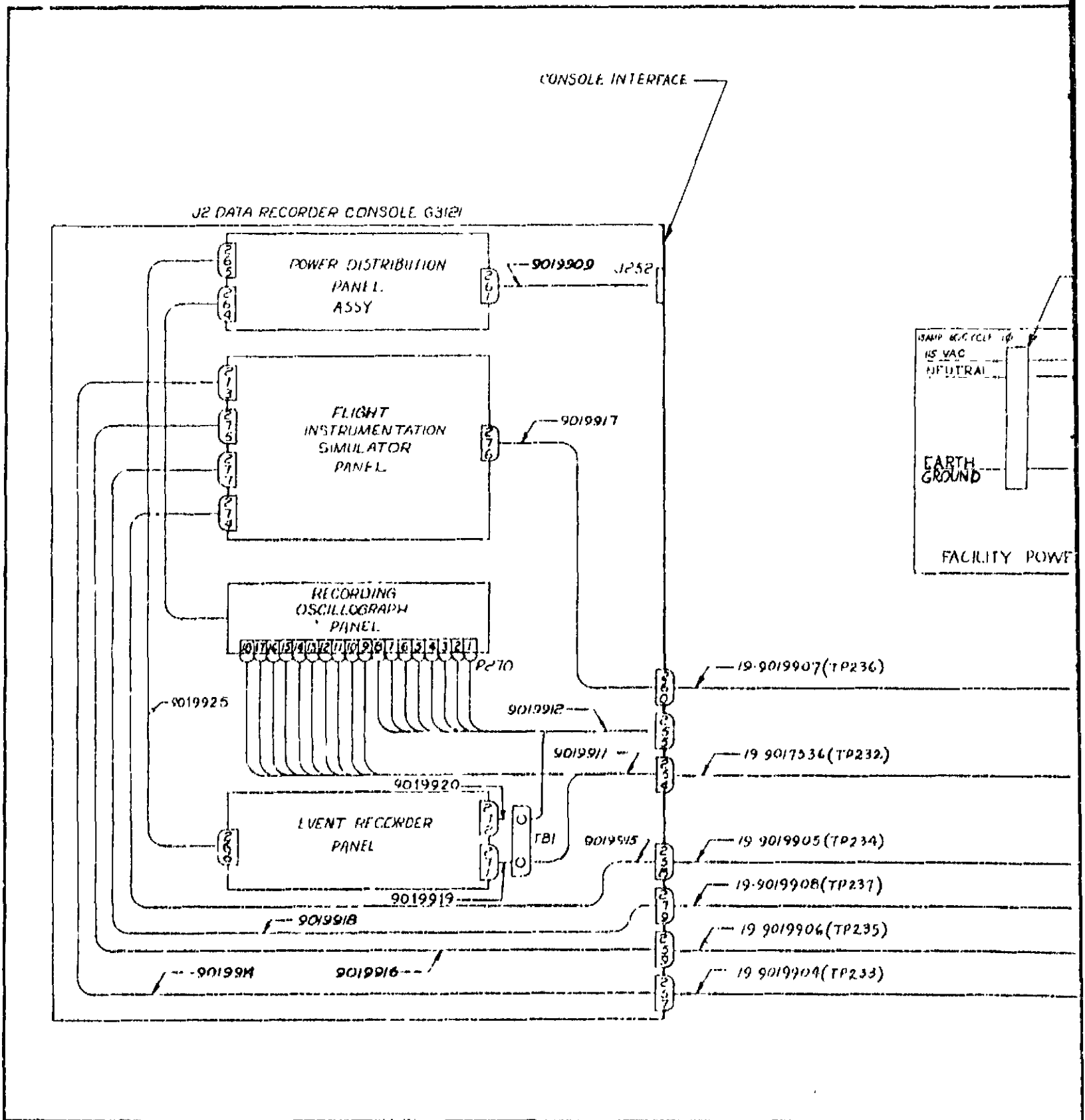
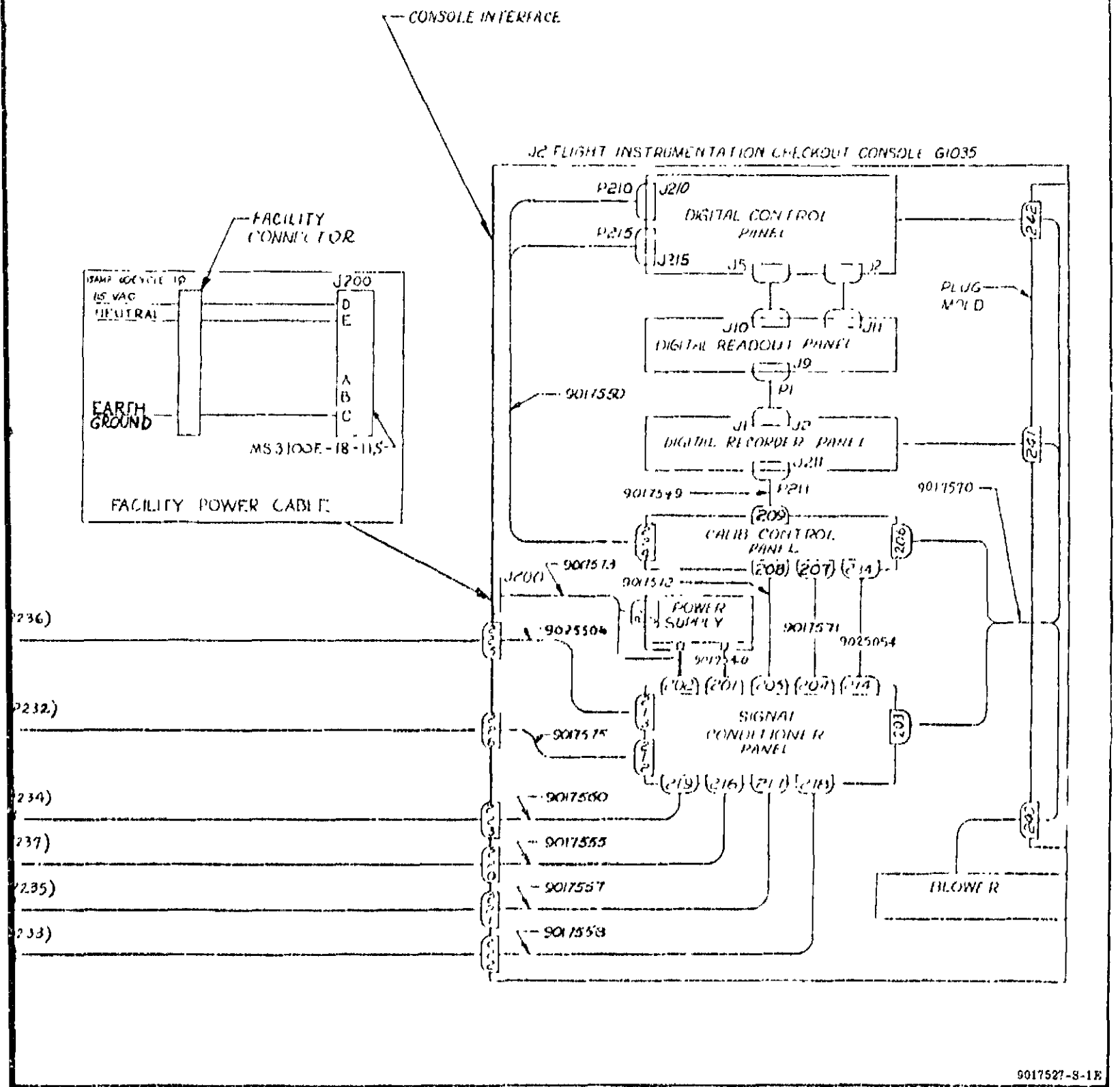


Figure 5-11. Flight Instrumentation Checkout Console Electrical Cabling Diagram


CONSOLE INTERFACE
J2 FLIGHT INSTRUMENTATION CHECKOUT CONSOLE G1035
FACILITY CONNECTOR
J200
D
E
A
B
C
EARTH GROUND
MS 3100E-18-11S
FACILITY POWER CABLE
P210
J210
DIGITAL CONTROL PANEL
P215
J215
J5
J2
PLUG MOLD
J10
J11
DIGITAL READOUT PANEL
J9
P1
9017550
J1
J2
DIGITAL RECORDER PANEL
J211
P211
9017549
9017570
209
CALIB CONTROL PANEL
208
207
214
206
9017543
9025504
POWER SUPPLY
9017544
9017571
9025054
202
201
205
204
214
SIGNAL CONDITIONER PANEL
203
219
216
217
218
9017560
9017555
9017557
9017558
BLOWER
242
241
240
2236)
2232)
2234)
2237)
2235)
2233)

Step	Loc	Operation	Loc	Result

NOTE: The following abbreviations are used in this figure:

B	Blower Panel
CC	Calibration Control Panel
DP	Data Printer
DR	Data Recorder G3121
DRER	Data Recorder Event Recorder Panel
DRS	Data Recorder Simulator Panel
DVM	Digital Voltohmmeter
IF	Interface Panel
Loc	Location
PS	Power Supply Panel
SC	Signal Conditioner Panel
TE	Test Equipment

- Delete steps preceded by asterisks (*) when performing an abbreviated function-test. See figure 5-10 for requirements for performing complete or abbreviated function-tests.
- Whenever voltage adjustment is required during this test, ensure locks on adjustment knobs (on panels incorporating locks) are loosened before and tightened after adjustment is made. Results are to be obtained with locknuts tightened.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 1 of 21)

Step	Loc	Operation	Loc	Result
1		Obtain the following test equipment: a. Multimeter, Model 630 (Triplett), or equivalent. b. Frequency Counter, Model 523CR (Hewlett Packard), or equivalent. c. Data Recorder Console G3121. (Data Recorder Console G3121MD4 or MD8 can be used with Flight Instrumentation Checkout Console G1035MD4 or MD10)		
*2	CC	Pull out 115 VAC and 28 VDC circuit breakers.		
*3	PS	Measure resistance between negative (-) terminal and ground terminal.	TE	Greater than 50K ohms.
*4	PS IF	Measure resistance between power supply ground terminal and J223 n.	TE	Greater than 50K ohms.
*5	IF	Measure resistance between the following:	TE	
		a. J223 n and k.		Less than one ohm.
		b. J200 B and C.		Greater than 50K ohms.
		c. J200 C and E.		Greater than 50K ohms.
6	CC	Depress the following RELEASE switches: a. PRESSURE TEST		No visible results.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 2 of 21)

Step	Loc	Operation	Loc	Result
		b. TEMPERATURE TEST. c. VALVE POSITION TEST. d. SPEED AND FLOW TEST.		
7	DVM DP PS	Ensure that all POWER switches are in the off position.		
8	IF TE	Connect external cables between flight instrumentation checkout console and data recorder console. (See figure 5-11.)		
9	IF	Connect facility power. See figure 5-11 for power and cable requirements.		
10	PS	Move POWER switch to ON.	PS	POWER light on.
11	PS	Adjust OUTPUT VOLTAGE knobs until 28 ±1.5 vdc is indicated on VOLTS DC meter.		
12	PS	Adjust MAXIMUM CURRENT ADJUST knob to 30.	PS	No visible results.
13	SC	Depress 25 AMP and 15 AMP circuit breakers.	SC	No visible results.
14	CC	Depress 115 VAC circuit breaker.	CC	STANDBY or CONSOLE POWER ON light on.
15	CC	If CONSOLE POWER ON light is on, momentarily depress CONSOLE POWER ON switch-light.	CC	CONSOLE POWER ON light off. STANDBY light on.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 3 of 21)

Step	Loc	Operation	Loc	Result
16	CC	Momentarily depress CONSOLE POWER ON switch-light.	CC	CONSOLE POWER ON light on.
				STANDBY light off.
			SC	115 VAC POWER ON light on.
			B	Blower operates.
17	CC	Depress 28 VDC circuit breaker.	CC	STANDBY or INSTRUMENT BUS POWER ON light on.
				If INSTRUMENT BUS POWER ON light is on, the following also occur:
				CALIBRATE or RUN light on.
				28 VDC meter indicates 28 ±3 vdc.
			SC	28 VDC POWER ON light on.
18	CC	If INSTRUMENT BUS POWER ON light is off, momentarily depress INSTRUMENT BUS POWER switch-light.	CC	INSTRUMENT BUS POWER ON light on.
				STANDBY light off.
				CALIBRATE or RUN light on.
				28 VDC meter indicates 28 ±3 vdc.
19	CC	Momentarily depress TEST LIGHTS switch.	CC	All lights on panel on momentarily except CHANNEL NO. lights.
20		(Deleted)		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 4 of 21)

Step	Loc	Operation	Loc	Result
				STANDBY light off.
				28 VDC POWER meter indicates 28 ±3 vdc.
			SC	28 VDC POWER ON light on.
21	DVM	Rotate switches as follows, then allow 15 minutes for warm-up before operating: a. POWER to ON. b. Function to VDC. c. MODE to STANDBY.	DVM	Display lights on.
22	DVM IF	Disconnect the following: a. P210 from J210. b. P222 from J222.		
23	DVM PS	Connect test leads between power supply panel OUTPUT terminals and the following: a. J210 A to + (positive). b. J210 B to - (negative).		
24	DVM	Rotate MODE switch to CONT. SCAN.	DVM	Voltage indicated on digital voltohmmeter.
25	PS	Adjust OUTPUT VOLTAGE until 28 ±0.05 vdc is indicated on digital voltohmmeter.	CC	28 VDC POWER meter indicates 28 ±1.0 vdc.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 5 of 21)

Step	Loc	Operation	Loc	Result
26	PS IF DVM	Disconnect test leads from power supply panel OUTPUT terminals and connect as follows: a. J223 v to J210 A. b. J223 w to J210 B.		
27	SC DVM	Loosen locknut and adjust power supply adjusting screw until 5.000 ±0.010 is indicated on digital volt-ohmmeter with locknut tightened.	CC	5 VDC POWER meter indicates 5.0 ±0.2 vdc.
28	IF DVM	Disconnect test leads from J210 and J222 and connect P210 to J210.		
29	DVM	Rotate MODE switch to STANDBY.		No visible results.
30	DVM	Disconnect P215 from J215.		
31	DVM IF TE	Connect test equipment to P215 and J222. See figure 5-13, test setup No. 2. Ground frequency counter to same ground as provided for chassis ground J200-C.		
NOTE:		Polarity of some multimeters may require connections to be reverse of those shown in figure 5-13 to obtain the correct input voltage.		
32	TE	Prepare frequency counter as follows to obtain a 20-volt signal at 10K cycles: a. Function selector to TIME INTERVAL.		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 6 of 21)

Step	Loc	Operation	Loc	Result
		b. Time unit to 10KC.		
		c. Trigger input to SEPARATE.		
		d. Trigger slope start to PLUS.		
		e. Trigger slope stop to PLUS.		
		f. Trigger level start to +20 vdc.		
		g. Trigger level stop to +20 vdc.		

NOTE: Settings are typical for frequency counter model 523CR. When an equivalent counter is used, settings and nomenclature may vary and it may be necessary to decrease the trigger level stop to a level which eliminates noise and permits the test to be accomplished.

33	CC	If RUN light is on, momentarily depress CALIBRATE/RUN switch-light.	CC	CALIBRATE light on. RUN light off.
34	CC	Momentarily depress PRESSURE SELECT switch-light.		PRESSURE SELECT light on.
35	CC	Depress PRESSURE TEST CHANNEL NO. 1 switch-light.	CC	CHANNEL NO. 1 light on.
36	CC	Momentarily depress LOW CALIB. TEST switch-light.	CC	LOW CALIB. TEST light on momentarily.
			TE	Frequency counter indicates 100-200 milliseconds.
37	TE	If results of step 36 are obtained, proceed to step 38. If results are not obtained, reset and readjust frequency counter, depress PRESSURE TEST RELEASE switch, and repeat steps 35 and 36.	CC	CHANNEL NO. 1 light off.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 7 of 21)

Step	Loc	Operation	Loc	Result
38	CC	Depress PRESSURE TEST RELEASE switch-light.	CC	CHANNEL NO. 1 light off.
39	TE	Reset frequency counter. Disconnect test equipment and connect it to P215. See figure 5-13, test setup No. 1.		
40	TE	Prepare frequency counter as follows to obtain a 10-volt signal at 10K cycles: a. Function selector to TIME INTERVAL. b. Time unit to 10KC. c. Trigger input to COMMON. d. Trigger slope start to plus. e. Trigger slope stop to minus. f. Trigger level start to +10 vdc. g. Trigger level stop to +10 vdc.		
41	CC	Depress PRESSURE TEST CHANNEL NO. 1 switch.	CC TE	CHANNEL NO. 1 light on. Frequency counter indicates 10-25 milliseconds.
42	CC	If results of step 41 are obtained, depress PRESSURE TEST RELEASE switch and proceed to step 43. If results are not obtained, reset and readjust frequency counter, depress PRESSURE TEST RELEASE switch, and repeat step 41.	CC	CHANNEL NO. 1 light off.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 8 of 21)

Step	Loc	Operation	Loc	Result
43	TE IF	Disconnect test equipment and connect P222 to J222 and P215 to J215.		
44	DR	Activate Data Recorder Console.		
45	CC	Momentarily depress GROUND HEATERS ON switch-light.	CC	GROUND HEATERS ON light on.
			DR	PRIMARY GROUND HEATER light on. AUXILIARY GROUND HEATER light on.
46	CC	Momentarily depress FLIGHT HEATERS ON switch-light.	CC	FLIGHT HEATERS ON light on.
			DR	PRIMARY FLIGHT HEATER light on. AUXILIARY FLIGHT HEATER light on.
47	DRS	Move TRANSDUCER SELECTION switches 1 through 20 to POT.		No visible results.
48	DVM	Rotate switches as follows: a. POWER to PRINT. b. Function to VDC. c. MODE to STANDBY.		No visible results.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 9 of 21)

Step	Loc	Operation	Loc	Result
49	DP	Move switches as follows: a. POWER to ON. b. RECORD to ON. c. SPACE SELECTOR to number 1.		No visible results.
50	DP	Pull out paper drawer to collect folded printout tape.		
51	CC	Momentarily depress CALIBRATE/RUN switch-light twice.	CC	CALIBRATE light off momentarily. PRESSURE SELECT light off.
52	CC	Momentarily depress PRESSURE SELECT switch-light.	CC	PRESSURE SELECT light on.
53	CC	Depress PRESSURE-TEST CHANNEL NO. 1 switch-light.	CC DP	CHANNEL NO. 1 light on. Prints.
54	CC	When DATA PRINTER stops printing, depress PRESSURE TEST RELEASE switch.	CC	CHANNEL NO. 1 light off.
55		Repeat steps 53 and 54 on PRESSURE TEST CHANNEL NO. 2 through 20.		Same results as in steps 53 and 54, on CHANNEL NO. 2 through 20.
56	DP	Remove printout tape and verify results. See figure 5-14 for an example and explanation of printout figures.	DP	Printouts identified as 1 through 6, and 31 through 44 indicate 2.500 ±0.100 volts.
57	DRS	Move all TRANSDUCER SELECT switches to DC-DC position.		No visible results.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 10 of 21)

Step	Loc	Operation	Loc	Result
58	CC	Depress PRESSURE-TEST CHANNEL NO. 1 switch-light.	CC	CHANNEL NO. 1 light on.
			DP	Prints.
59	CC	When DATA PRINTER stops printing, depress and hold LOW CALIB. TEST switch-light until DATA PRINTER completes printing cycle.	DP	Prints.
60	CC	Depress and hold HIGH CALIB. TEST switch-light until DATA PRINTER completes printing cycle.	DP	Prints.
61	CC	Depress PRESSURE TEST RELEASE switch.	CC	CHANNEL NO. 1 light off.
62		Repeat steps 58 through 61 on PRESSURE TEST CHANNEL NO. 2 through 20, and 24.		Same results as in steps 58 through 61, on CHANNEL NO. 2 through 20, and 24.
63	DP	Remove printout tape and verify results.	DP	Printouts printed in groups of 3 and identified as 1 through 6 and 31 through 44, and 63 indicating 0.984 ±0.200, 2.300 ±0.400, and 3.780 ±0.400 volts.
64	CC	Momentarily depress FLIGHT HEATERS ON switch-light.	CC	FLIGHT HEATERS ON light off.
			DRS	PRIMARY FLIGHT HEATER light off.
				AUXILIARY FLIGHT HEATER light off.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 11 of 21)

Step	Loc	Operation	Loc	Result
65	CC	Momentarily depress GROUND HEATERS ON switch-light.	CC	GROUND HEATERS ON light off.
			DRS	PRIMARY GROUND HEATER light off.
				AUXILIARY GROUND HEATER light off.
66		Perform temperature-test circuit-test (paragraph 5-36) then proceed to step 67. It is not necessary to perform steps of temperature-test circuit test that prepare console for use or secure console.		
*67	DRS	Move VALVE POSITION switches 1 through 4 to CLOSE, and 5 through 8 to OPEN.		No visible results.
*68	TE IF	Measure voltage between J226 U (negative) and the following:	TE	28 ±1 vdc.
		J226 i		
		J226 j		
		J226 g		
		J226 e		
*69	DRS	Move VALVE POSITION switches 1 through 4 to OPEN.		No visible results.
*70		Repeat step 68.	TE	Zero ±1 vdc.
*71	TE	Measure voltage between J226 U (negative) and the following:	TE	28 ±1 vdc.
		J226 k		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 12 of 21)

Step	Loc	Operation	Loc	Result
		J226 h		
		J226 f		
		J226 d		
		J226 c		
		J226 b		
		J226 C		
		J226 D		
*72	DRS	Move VALVE POSITION switches 1 through 8 to CLOSE.		No visible results.
*73		Repeat step 71.	TE	Zero ±1 vdc.
74	CC	Momentarily depress VALVE POSITION SELECT switch-light.	CC	VALVE POSITION SELECT light on.
75	CC	Depress VALVE POSITION SELECT CHANNEL NO. 1 switch-light.	CC DP	CHANNEL NO. 1 light on. Prints.
76	CC	When DATA PRINTER stops printing, depress VALVE POSITION TEST RELEASE switch.	CC	CHANNEL NO. 1 light off.
77		Repeat steps 75 and 76 on VALVE POSITION SELECT CHANNEL NO. 2 through 6.		Same results as in steps 75 and 76, on CHANNEL NO. 2 through 6.
78	DP	Remove printout tape and verify results.	DP	Printouts, identified as 19 through 24, indicating 2.500 ±0.090 volts.
79	DVM	Rotate POWER switch to ON.		No visible results.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 13 of 21)

Step	Loc	Operation	Loc	Result
80	CC	Momentarily depress SPEED AND FLOW SELECT switch-light.	CC	SPEED AND FLOW SELECT light on.
81	IF	Disconnect P221 from J221.		VALVE POSITION SELECT light off.
82	TE IF	Connect frequency counter and VTVM to J221A (ground) and J221B.		
83	TE	Prepare frequency counter to record a maximum of 10,000 cps and VTVM to measure AC.		
84	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 1 switch-light. If voltage result is not obtained, adjust trimpot 5500. Trimpot 5500 is located on frequency generator Z75.	CC TE	CHANNEL NO. 1 light on. Frequency counter indicates 5,500 ±5 cps and VTVM indicates 3.5 ±0.4 volts rms.
85	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 1 light off.
86	TE	Reset frequency counter.		
87	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 2 switch-light. If voltage result is not obtained, adjust trimpot 5300. Trimpot 5300 is located on frequency generator Z75.	CC TE	CHANNEL NO. 2 light on. Frequency counter indicates 5,300 ±5 cps and VTVM indicates 3.5 ±0.4 volts rms.
88	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 2 light off.
89	TE IF	Reset frequency counter, then disconnect test equipment from J221A and J221B and reconnect it to J221E (ground) and J221F.		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 14 of 21)

Step	Loc	Operation	Loc	Result
90	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 3 switch-light. If voltage result is not obtained, adjust trimpot 2000. Trimpot 2000 is located on frequency generator Z75.	CC TE	CHANNEL NO. 3 light on. Frequency counter indicates 2,000 ±2 cps and VTVM indicates 3.5 ±0.4 volts rms.
91	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 3 light off.
92	TE	Reset frequency counter.		
93	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 4 switch-light. If voltage result is not obtained, adjust trimpot 1692. Trimpot 1692 is located on frequency generator Z75.	CC TE	CHANNEL NO. 4 light on. Frequency counter indicates 1,692 ±2 cps and VTVM indicates 3.5 ±0.4 volts rms.
94	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 4 light off.
95	TE IF	Reset frequency counter, then disconnect test equipment from J221E and J221F and reconnect it to J221J (ground) and J221K.		
96	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 5 switch-light. If voltage result is not obtained, adjust trimpot 200. Trimpot 200 is located on frequency generator Z75.	CC TE	CHANNEL NO. 5 light on. Frequency counter indicates 200 ±2 cps and VTVM indicates 3.5 ±0.4 volts rms.
97	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 5 light off.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 15 of 21)

Step	Loc	Operation	Loc	Result
98	TE IF	Reset frequency counter, then disconnect test equipment from J221J and J221K and reconnect it to J221R (ground) and J221S.		
99	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 6 switch-light.	CC	CHANNEL NO. 6 light on.
			TE	Frequency counter indicates 200 +2 cps and VTVM indicates 3.5 +0.4 volts rms.
100	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 6 light off.
101	TE IF	Disconnect test equipment and connect P221 to J221.		
102	DVM	Rotate MODE switch to CONT. SCAN.	DVM	Voltage indicated on digital voltohmmeter.
103	CC DVM	Depress SPEED AND FLOW TEST CHANNEL NO. 1 switch-light. Wait 5 seconds, then momentarily rotate POWER switch to PRINT.	CC DP	CHANNEL NO. 1 light on. Printout number 25 indicates 4.583 ±0.015 vdc.
104		If results of step 103 are obtained, proceed to step 106. If results are not obtained, perform steps 105 and 106 to adjust pulse-rate integrator Z71 to a value of 4.583 +0.008 vdc, then repeat step 103.		
105	SC DVM	Adjust pulse-rate to desired value by rotating adjusting screw at top corner of pulse-rate integrator, and verifying results on digital volt-ohmmeter.		
106	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 1 light off.
107	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 2 switch-light. Wait 5 seconds, then momentarily rotate POWER switch to print.	CC DP	CHANNEL NO. 2 light on. Printout number 26 indicates 4.416 ±0.020 vdc.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 16 of 21)

Step	Loc	Operation	Loc	Result
108		If results of step 107 are obtained, proceed to step 109. If results are not obtained, repeat steps 105 and 106 to adjust pulse-rate integrator Z72 to a value of 4.416 ±0.008 vdc, then repeat step 107.	CC	CHANNEL NO. 2 light off when step 106 is repeated.
109	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 2 light off.
110	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 3 switch-light. Wait 5 seconds then momentarily rotate POWER switch to print.	CC DP	CHANNEL NO. 3 light on. Printout number 27 indicates 5.000 ±0.015 vdc.
111	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 3 light off.
112	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 4 switch-light. Wait 5 seconds, then momentarily rotate POWER switch to PRINT.	CC DP	CHANNEL NO. 4 light on. Printout number 28 indicates 4.231 ±0.020 vdc.
113	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL No. 4 light off.
114	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 5 switch-light. Wait 5 seconds, then momentarily rotate POWER switch to print.	CC DP	CHANNEL NO. 5 light on. Printout number 29 indicates 3.333 ±0.015 vdc.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 17 of 21)

Step	Loc	Operation	Loc	Result
115		If results of step 114 are obtained, proceed to step 116. If results are not obtained, perfor steps 105 and 106 to adjust pulse-rate integrator Z73 to a value of 3.333 ±0.008 vdc, then repeat step 114.	CC	CHANNEL NO. 5 light off when step 106 is repeated.
116	CC	Depress SPEED AND FLOW RELEASE switch-light.	CC	CHANNEL NO. 5 light off.
117	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 6 switch-light. Wait 5 seconds, then momentarily rotate POWER switch to PRINT.	CC DP	CHANNEL NO. 6 light on. Printout number 30 indicates 3.333 ±0.015 vdc.
118		If results of step 117 are obtained, proceed to step 119. If results are not obtained perform steps 105 and 106 to adjust pulse-rate integrator Z74 to a value of 3.333 ±0.008 vdc, then repeat step 117.	CC	CHANNEL NO. 6 light off when step 106 is repeated.
119	CC	Depress SPEED AND FLOW RELEASE switch-light.	CC	CHANNEL NO. 6 light off.
120	DVM	Rotate MODE switch to STANDBY and POWER switch to PRINT.		No visible results.
121	IF	Disconnect J225 from P225.		
122	DVM	Move RECORD switch to OFF.		No visible results.
123	TE IF	Connect frequency counter to J225-E (negative) and J225-D.	CC	CHANNEL NO. 1 light on.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 18 of 21)

Step	Loc	Operation	Loc	Result
124	TE IF	Connect ground wire between J226m and frequency counter ground terminal.		
125	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 1 switch-light.	CC	CHANNEL NO. 1 light on.
			TE	Frequency counter indicates 5,500 ±5 cps.
126	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 1 light off.
			TE	Frequency indication lost.
127	TE	Disconnect frequency counter from J225-E and J225-D, and reconnect it to J226-R (negative) and J226-S.		
128	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 1 switch-light.	CC	CHANNEL NO. 1 light on.
			TE	Frequency counter indicates 5,500 ±5 cps.
129	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 1 light off.
			TE	Frequency indication lost.
130	TE IF	Disconnect frequency counter from J226-R and J226-S and reconnect it to J225-K (negative) and J225-J.		
131	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 3 switch-light.	CC	CHANNEL NO. 3 light on.
			TE	Frequency counter indicates 2,000 ±2 cps.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 19 of 21)

Step	Loc	Operation	Loc	Result
132	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 3 light off.
			TE	Frequency indication lost.
133	TE	Disconnect frequency counter from J225-K and J225-J, and reconnect it to J226-X (negative) and J226-Y.		
134	CC	Depress SPEED AND FLOW CHANNEL NO. 3 switch-light.	CC	CHANNEL NO. 3 light on.
			TE	Frequency counter indicates 2,000 ±2 cps.
135	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 3 light off.
			TE	Frequency indication lost.
136	TE IF	Disconnect frequency counter from J226-X and J226-Y and reconnect it to J226-V (negative) and J226-W.		
137	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 5 switch-light.	CC	CHANNEL NO. 5 light on.
			TE	Frequency counter indicates 200 ±2 cps.
137A	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 5 light off.
			TE	Frequency indication lost.
137B	TE IF	Disconnect frequency counter from J226-V and J226-W and reconnect it to J225-U (negative) and J225-T.		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 20 of 21)

Step	Loc	Operation	Loc	Result
137C	CC	Depress SPEED AND FLOW TEST CHANNEL NO. 6 switch-light.	CC	CHANNEL NO. 6 light on.
			TE	Frequency counter indicates 200 ±2 cps.
137D	CC	Depress SPEED AND FLOW TEST RELEASE switch-light.	CC	CHANNEL NO. 6 light off.
			TE	Frequency indication lost.
138	TE	Disconnect frequency counter.		
139	DP	Move RECORD switch to ON.		No visible results.
140	TE IF	Measure voltage between J225N (negative) and J225P.	TE	Zero vdc.
141	CC	Momentarily depress CALIBRATE/RUN switch-light.	CC	RUN light on. CALIBRATE light off.
			TE	28 ±1 vdc.
142	IF TE	Disconnect multimeter and connect P225 to J225.		
143	CC	Momentarily depress INSTRUMENTATION BUS POWER ON/STANDBY switch-light.	CC	STANDBY light on. INSTRUMENTATION BUS POWER ON light off. RUN light off. 28 VDC POWER meter indicates zero. 5 VDC POWER meter indicates zero.
			SC	28 VDC POWER ON light off.

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 20A of 21)

Step	Loc	Operation	Loc	Result
144	CC	Momentarily depress CONSOLE POWER ON/STANDBY switch-light.	CC	STANDBY light on.
				CONSOLE POWER ON light off.
			SC	115 VAC POWER ON light off.
			B	Blower ceases operation.
145	PS	Move POWER switch to OFF.	CC	STANDBY light (CONSOLE POWER ON) fades.
146		Move all switches to off or down position.		
147	CC SC	Pull out all circuit breakers.		
148		Deenergize facility power to console.		
149	IF	Disconnect test cables and install protective caps on electrical connectors and console interface receptacles.		

Figure 5-12. Function-Testing Flight Instrumentation Checkout Console (Sheet 21 of 21)

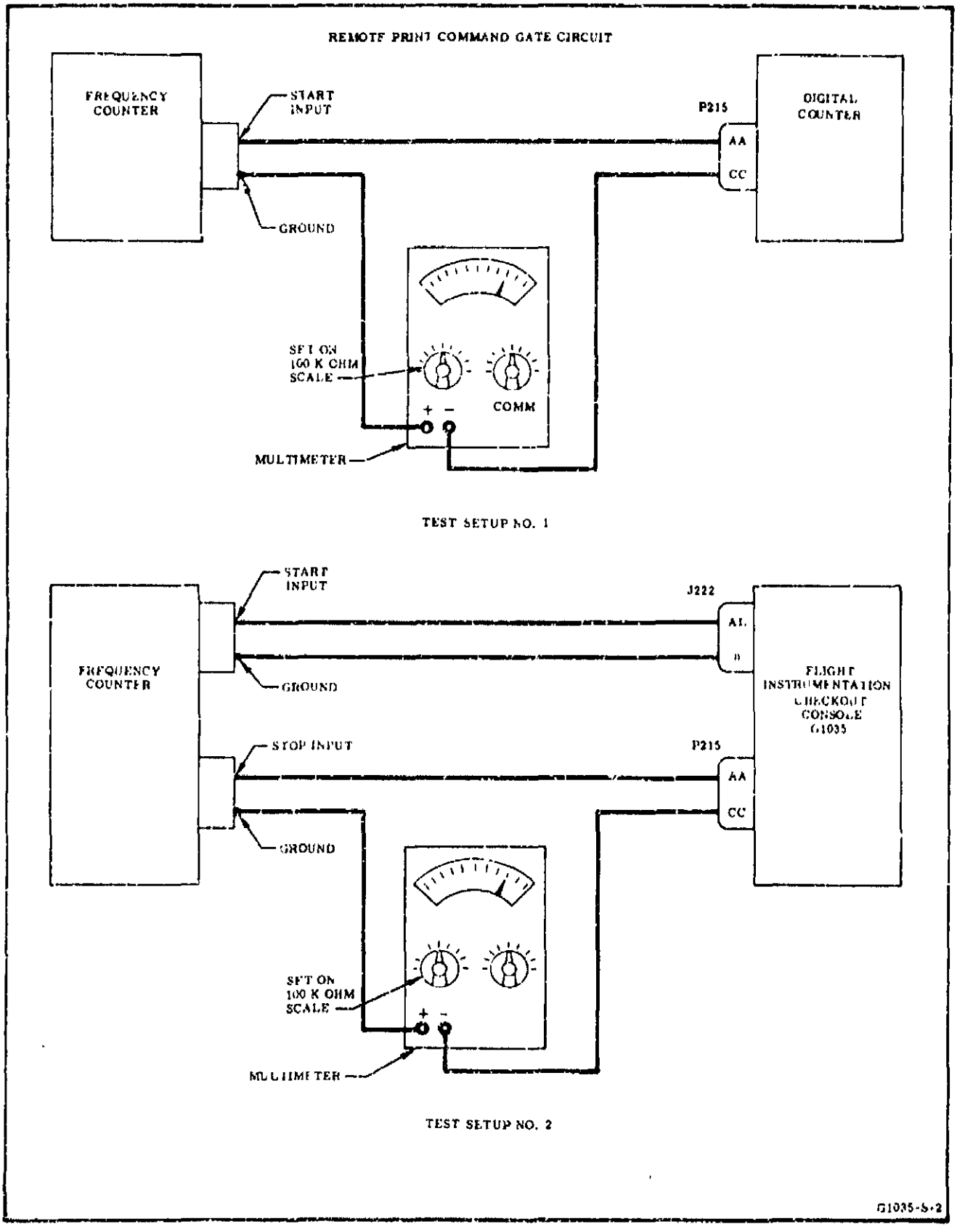


Figure 5-13. Remote Print Command Gate Circuit Test Setup

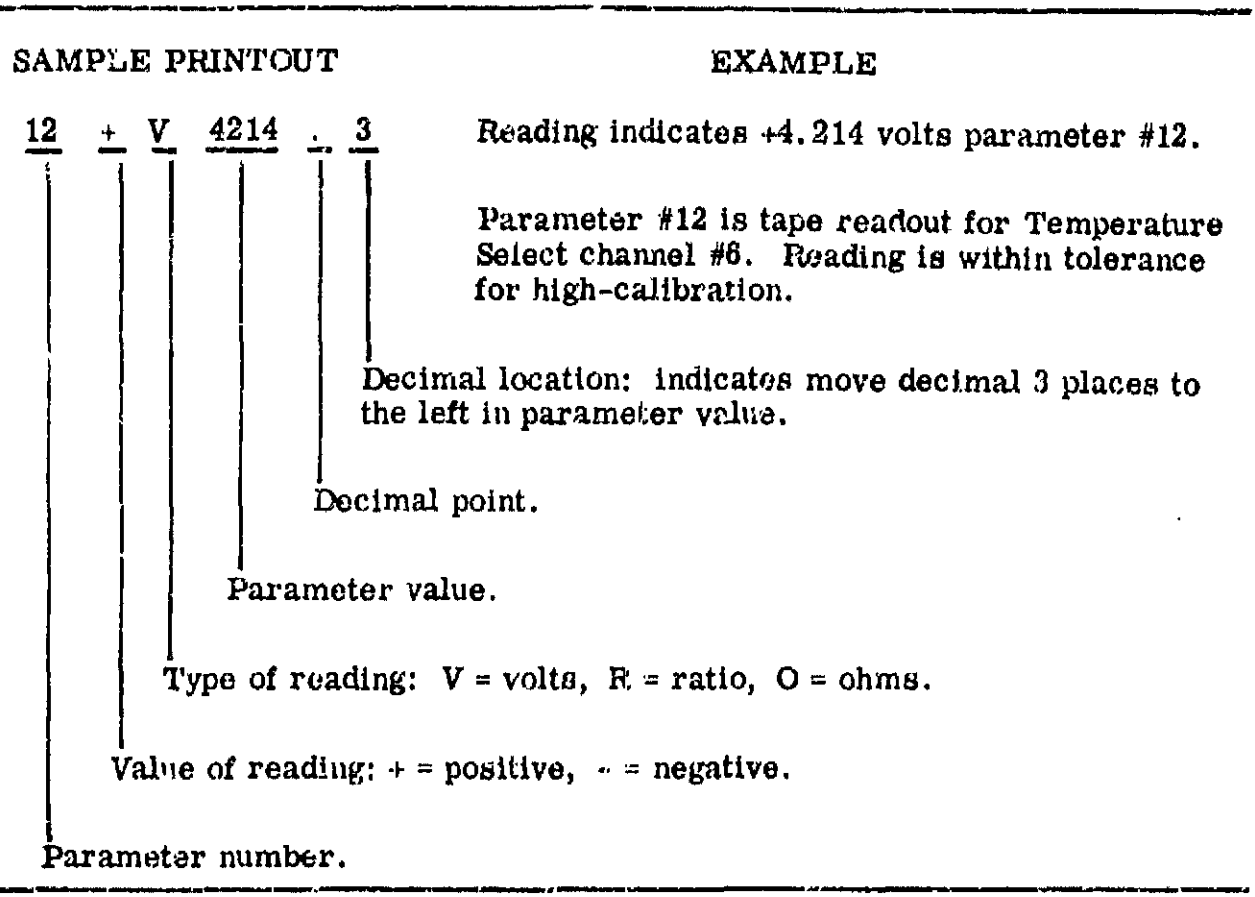

SAMPLE PRINTOUT
EXAMPLE
12 + V 4214 . 3
Reading indicates +4.214 volts parameter #12.
Parameter #12 is tape readout for Temperature Select channel #6. Reading is within tolerance for high-calibration.
Decimal location: indicates move decimal 3 places to the left in parameter value.
Decimal point.
Parameter value.
Type of reading: V = volts, R = ratio, O = ohms.
Value of reading: + = positive, - = negative.
Parameter number.

Figure 5-14. Reading Digital Recorder Printout Tape

5-36. TESTING TEMPERATURE-TEST CIRCUIT.

5-37. Testing the console temperature-test circuit must be performed in the order specified and at an ambient temperature of 75° ±25° F. Personnel must take the necessary safety precautions for electrical equipment. See figure 5-15 for test procedures, figure 5-16 for temperature-test amplifier voltages, and figure 5-17 for electrical schematic.

Step	Loc	Operation	Loc	Result

NOTE: The following abbreviations are used in this figure:

B	Blower Panel
CC	Calibration Control Panel
DP	Data Printer
DR	Data Recorder G3121
DVM	Digital Voltohmmeter
IF	Interface Panel
Loc	Location
PS	Power Supply Panel
SC	Signal Conditioner Panel
TE	Test Equipment

- Whenever voltage adjustment is required during this test, ensure locks on adjustment knobs (on panels incorporating locks) are loosened before and tightened after adjustment is made. Results are to be obtained with locknuts tightened.

1		Obtain Data Recorder Console G3121. Console G3121MD4 or MD8 can be used with Flight Instrumentation Console G1035MD4 or MD10.		
2	CC SC	Ensure that 115 VAC and 28 VDC circuit breakers are pulled out.		
3	DVM DP PS	Ensure that all POWER switches are in the off position.		
4	IF DR	Connect external cables between flight instrumentation console and data recorder console. (See figure 5-11.)		

Figure 5-15. Testing Temperature-Test Circuit (Sheet 1 of 8)

Step	Loc	Operation	Loc	Result
5	IF	Connect facility power. See figure 5-11 for power and cable requirements.		
6	PS	Move POWER switch to ON.	PS	POWER light on.
7	PS	Adjust OUTPUT VOLTAGE knobs until 28 ±1.5 vdc is indicated on VOLTS DC meter.		
8	PS	Adjust MAXIMUM CURRENT ADJUST knob until 30 amperes is indicated on AMPERES DC meter.		
9	SC	Depress 25 AMP and 15 AMP circuit breakers.		No visible results.
10	CC	Depress the following RELEASE switches: a. PRESSURE TEST b. TEMPERATURE TEST c. VALVE POSITION TEST d. SPEED AND FLOW TEST.		No visible results.
11	CC	Depress 115 VAC circuit breaker.	CC	STANDBY or CONSOLE POWER ON light on.
12	CC	If CONSOLE POWER ON light is on momentarily depress CONSOLE POWER ON switch-light.	CC	CONSOLE POWER ON light off. STANDBY light on.
13	CC	Momentarily depress CONSOLE POWER ON switch-light.	CC SC B	CONSOLE POWER ON light on. 115 VAC POWER ON light on. Blower operates.

Figure 5-15. Testing Temperature-Test Circuit (Sheet 2 of 3)

Step	Loc	Operation	Loc	Result
14	CC	Depress 28 VDC circuit breaker.	CC	STANDBY or INSTRUMENT BUS POWER ON light on.
				If INSTRUMENT BUS POWER ON light is on, the following also occur:
				CALIBRATE or RUN light on.
				28 VDC meter indicates 28 ±3 vdc.
			SC	28 VDC POWER ON light on.
15	CC	If INSTRUMENT BUS POWER ON light is on, momentarily depress INSTRUMENT BUS POWER ON switch-light.	CC	INSTRUMENT BUS POWER ON light off.
				STANDBY light on.
				CALIBRATE or RUN light off.
				28 VDC meter indicates zero.
			SC	28 VDC POWER ON light off.
16	CC	Momentarily depress INSTRUMENT BUS POWER ON switch-light.	CC	INSTRUMENT BUS POWER ON light on.
				STANDBY light off.
				CALIBRATE or RUN light on.
				28 VDC POWER meter indicates 28 ±3 vdc.
			SC	28 VDC POWER ON light on.

Figure 5-15. Testing Temperature-Test Circuit (Sheet 3 of 8)

Step	Loc	Operation	Loc	Result
17	CC	If RUN light is on, momentarily depress CALIBRATE/RUN switch-light.	CC	CALIBRATE light on. RUN light off.
18	DVM	Rotate switches as follows:		
		a. POWER to PRINT.		No visible results.
		b. Function to VDC.		
		c. MODE to STANDBY		
19	DP	Move switches as follows:		
		a. POWER to ON		No visible results.
		b. RECORD to ON		
		c. SPACE SELECTOR to number 1.		
20	DP	Pull out paper drawer to collect folded printout tape.		
21	CC	Momentarily depress TEMPERATURE SELECT switch-light.	CC	TEMPERATURE SELECT light on.
22	CC	Depress TEMPERATURE TEST CHANNEL NO. 1 switch-light.	CC	CHANNEL NO. 1 light on.
			DP	Prints.
23	CC	When DATA PRINTER stops printing, depress and hold LOW CALIB. TEST switch-light, until DATA PRINTER completes printing cycle, then release switch-light.	CC	LOW CALIB. TEST light on while switch-light is depressed.
			DP	Prints.

Figure 5-15. Testing Temperature-Test Circuit (Sheet 4 of 8)

Step	Loc	Operation	Loc	Result
24	CC	Depress and hold HIGH CALIB. TEST switch-light, until DATA PRINTER completes printing cycle, and release switch-light.	CC	HIGH CALIB. TEST light on while switch-light is depressed.
			DP	Prints.
25	CC	Depress TEMPERATURE TEST RELEASE switch.	CC	CHANNEL NO. 1 switch-light off.
26		Repeat steps 22 through 24 on TEMPERATURE TEST CHANNEL NO. 2 through 6, 9 through 14, 23, 24, and 26.		Same results as in steps 22 through 24, on CHANNEL NO. 2 through 6, 9 through 14, 23, 24 and 26.
27	CC	Depress TEMPERATURE TEST CHANNEL NO. 7 switch-light.	CC	CHANNEL NO. 7 light on.
			DP	Prints.
28	CC	When DATA PRINTER stops printing, depress and hold LOW CALIB. TEST switch-light until DATA PRINTER completes printing cycle, then release switch-light.	CC	LOW CALIB. TEST light on while switch-light is depressed.
			DP	Prints.
29	CC	Depress and hold HIGH CALIB. TEST switch-light until DATA PRINTER completes printing cycle, then release switch-light.	CC	HIGH CALIB. TEST light on while switch-light is depressed.
			DP	Prints.
30	CC	Simultaneously depress and hold LOW CALIB. TEST and HIGH CALIB. TEST switch-lights until DATA PRINTER completes printing cycle, then release switch-lights.	CC	HIGH CALIB. TEST light on while switch-light is depressed.
				LOW CALIB. TEST light on while switch-light is depressed.
			DP	Prints.

Figure 5-15. Testing Temperature-Test Circuit (Sheet 5 of 8)

Step	Loc	Operation	Loc	Result
31	CC	Depress TEMPERATURE TEST RELEASE switch-light.	CC	CHANNEL NO. 7 light off.
32		Repeat steps 27 through 30 on TEMPERATURE TEST CHANNEL NO. 8 and 15 through 22.		Same results as in steps 27 through 30, on CHANNEL NO. 8 and 15 through 22.
33	DP	Remove and verify printout tapes obtained in steps 22 through 32. See figure 5-14 for an example and explanation of printout figures.	DP	85 printouts obtained. Voltages must agree with those listed in figure 5-16.
34		If the values obtained agree with the values in figure 5-16, proceed to step 43. If the values do not agree, perform steps 35 through 42 for all amplifiers requiring adjustment. Begin with the amplifier having the largest Z number requiring adjustment.		
35	SC	Remove 2 amplifiers having the next 2 larger Z numbers than amplifier requiring adjustment. Remove access cover from amplifier requiring adjustment.		
36	DVM	Rotate switches as follows: a. POWER to ON. b. MODE to CONT. SCAN.		
37	CC SC DVM	Depress and hold HIGH CALIB. TEST and adjust amplifier gain until voltage ±0.008 (in THIRD VOLTAGE column figure 5-16) is obtained.		

Figure 5-15. Testing Temperature-Test Circuit (Sheet 6 of 8)

Step	Loc	Operation	Loc	Result
38	CC SC DVM	Depress and hold LOW CALIB. TEST and adjust zero control until voltage ±0.008 (in SECOND VOLTAGE column figure 5-16) is obtained.		
39		Repeat steps 37 and 38.		
40	SC	Install amplifiers.		
41	DVM	Rotate switches as follows: a. POWER to PRINT b. MODE to STANDBY.		No visible results.
42		Repeat steps 20 through 22 after allowing amplifiers to warm up for 15 minutes.		
43	CC	Momentarily depress INSTRUMENT BUS POWER ON/STANDBY switch-light.	CC	STANDBY light on. INSTRUMENT BUS POWER ON light off. 28 VDC POWER meter indicates zero. 5 VDC POWER meter indicates zero.
			SC	28 VDC POWER ON light off.
44	CC	Momentarily depress CONSOLE POWER ON/STANDBY switch-light.	CC	STANDBY light on. CONSOLE POWER ON light on.
			SC	115 VAC POWER ON light off.
			B	Blower stops.

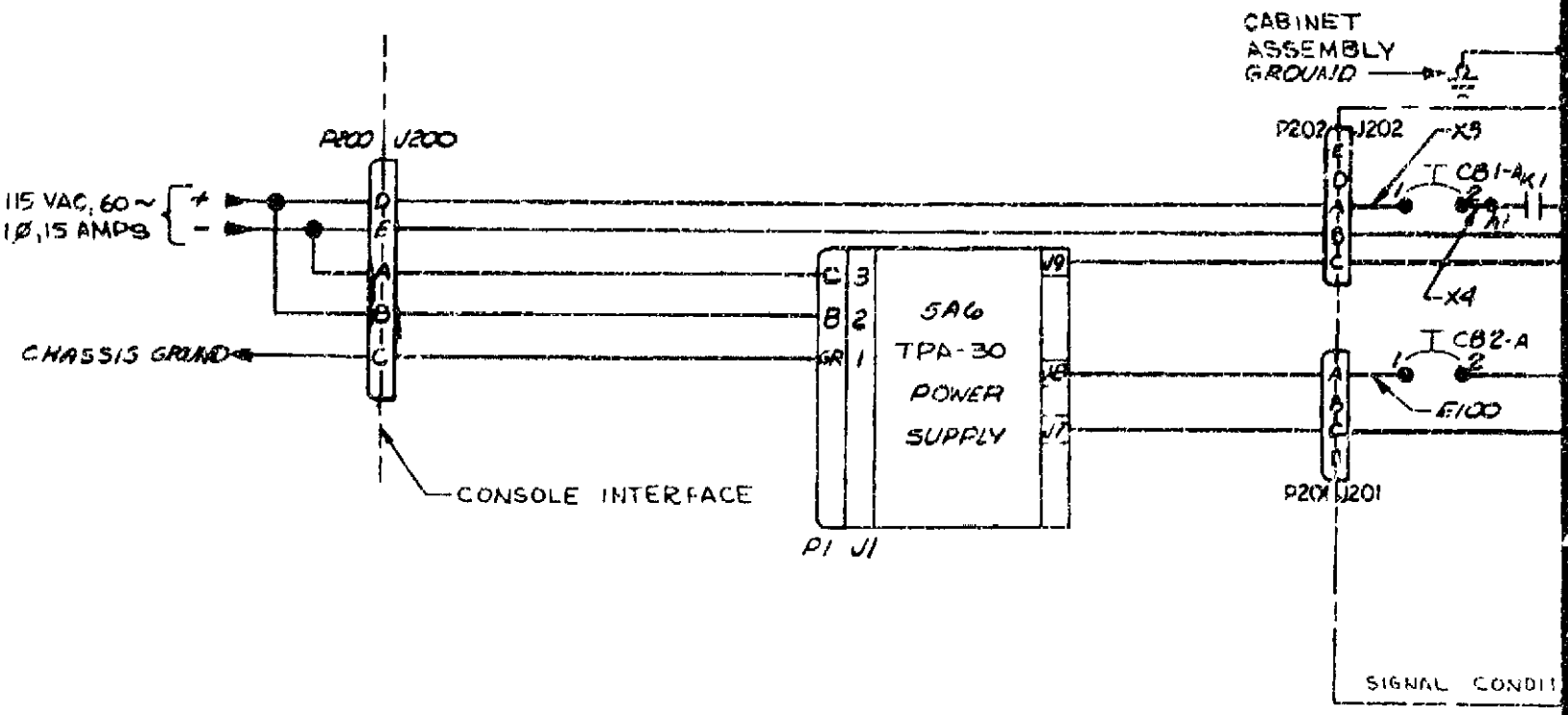
Figure 5-15. Testing Temperature-Test Circuit (Sheet 7 of 8)

Step	Loc	Operation	Loc	Result
45	PS	Move POWER switch to OFF.	CC	STANDBY light (CONSOLE POWER ON) fades.
		Move all switches to off or down position.		
46	SC CC	Pull out all circuit breakers.		
47		Deenergize facility power to console.		
48	IF	Disconnect test cables and install protective caps on electrical connectors and console interface receptacles.		

Figure 5-15. Testing Temperature-Test Circuit (Sheet 8 of 8)

Channel Number	Printout Number	Amplified Number	First Voltage ±0.250	Second Voltage ±0.016	Third Voltage ±0.016	Fourth Voltage ±0.250
1	7	Z521	2.514	0.888	4.098	- - -
2	8	Z522	2.514	0.888	4.098	- - -
3	9	Z523	2.514	0.888	4.098	- - -
4	10	Z524	2.619	1.100	4.023	- - -
5	11	Z525	2.654	1.070	3.860	- - -
6	12	Z526	3.046	1.125	3.980	- - -
7	13	Z527	3.044	1.075	3.950	3.721
8	14	Z528	1.031	0.602	3.615	3.560
9	15	Z529	2.739	1.120	4.110	- - -
10	16	Z530	2.739	1.120	4.110	- - -
11	17	Z531	2.517	1.075	3.950	- - -
12	18	Z532	2.517	1.075	3.950	- - -
13	45	Z533	2.517	1.075	3.950	- - -
14	46	Z534	2.385	1.097	4.065	- - -
15	47	Z535	1.637	0.440	3.448	3.450
16	48	Z536	1.637	0.440	3.448	3.450
17	49	Z537	3.044	1.075	3.950	3.721
18	50	Z538	3.044	1.075	3.950	3.721
19	51	Z539	3.044	1.075	3.950	3.721
20	52	Z540	1.775	0.415	3.622	3.606
21	53	Z541	3.044	1.075	3.950	3.721
22	54	Z542	1.031	0.602	3.615	3.560
23	55	Z543	2.739	1.120	4.110	- - -
24	56	Z544	2.385	1.097	4.065	- - -
26	58	Z546	2.517	1.065	3.936	- - -

Figure 5-16. Temperature-Test Amplifier Voltages



NOTE

A CIRCLED LETTER INDICATES THAT THE COMPONENT SCHEMATIC CAN BE FOUND IN THE ZONE IDENTIFIED BY THE ADJACENT CODE.

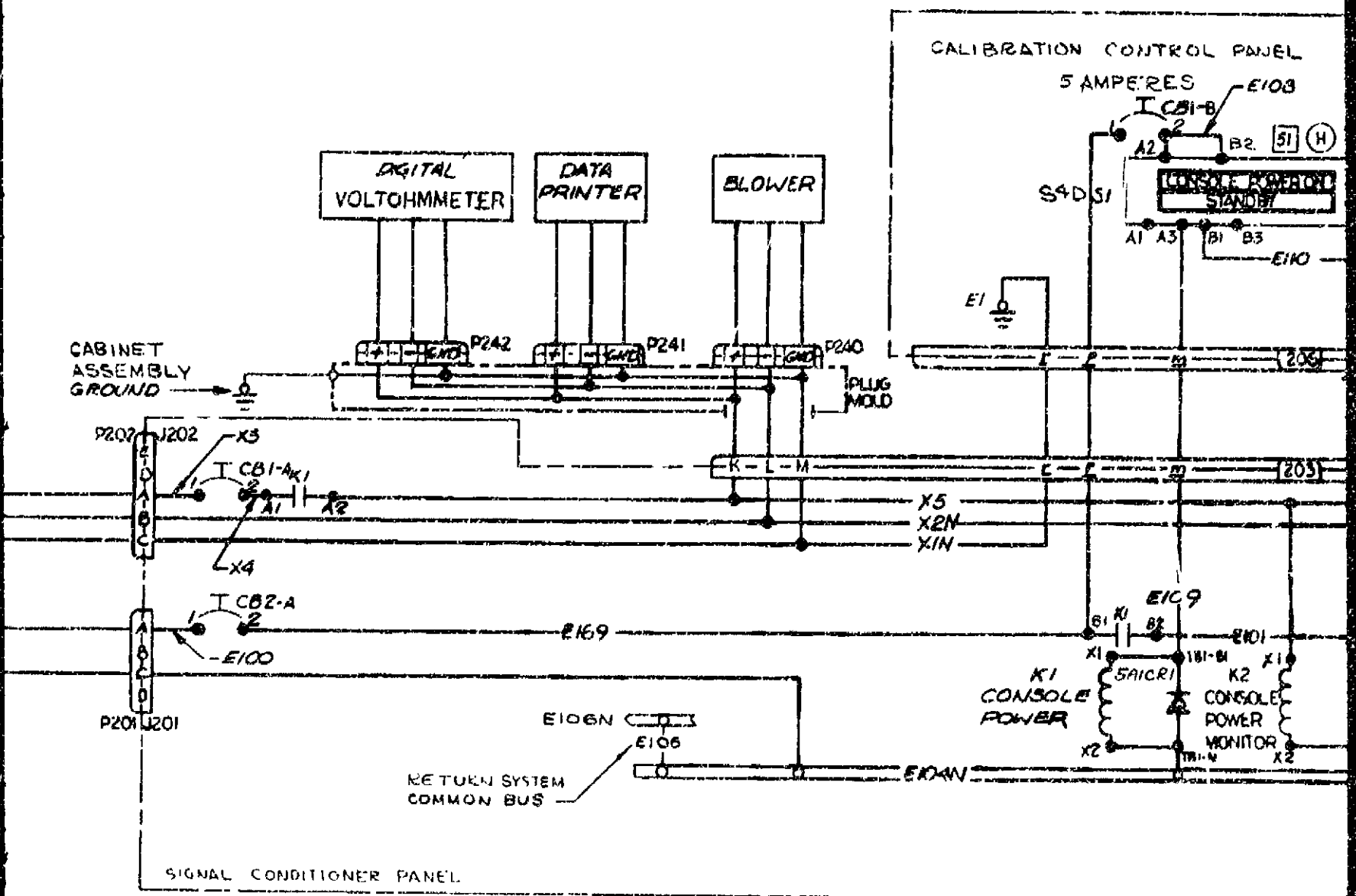


Figure 3-17. Electrical Checkout

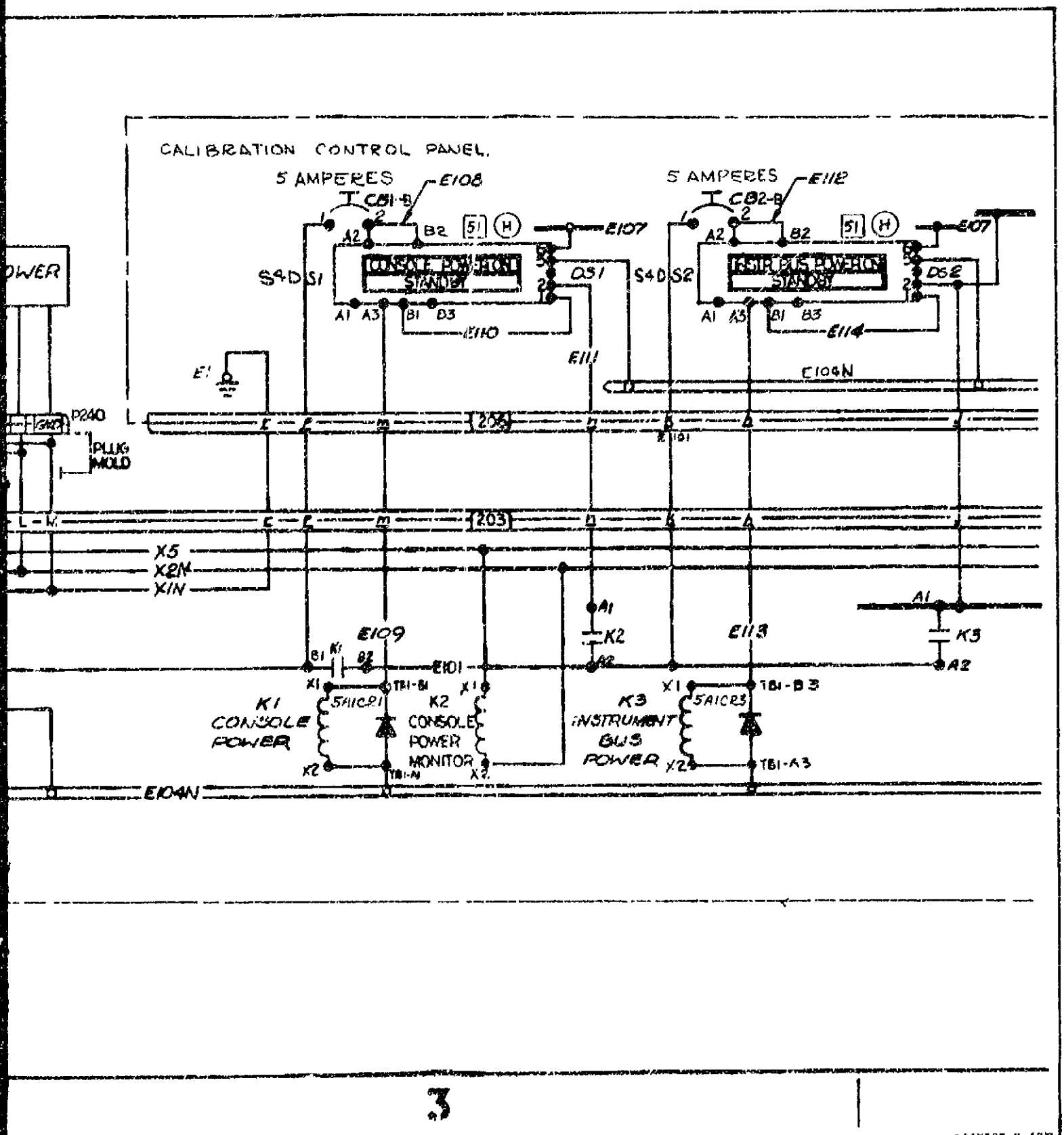
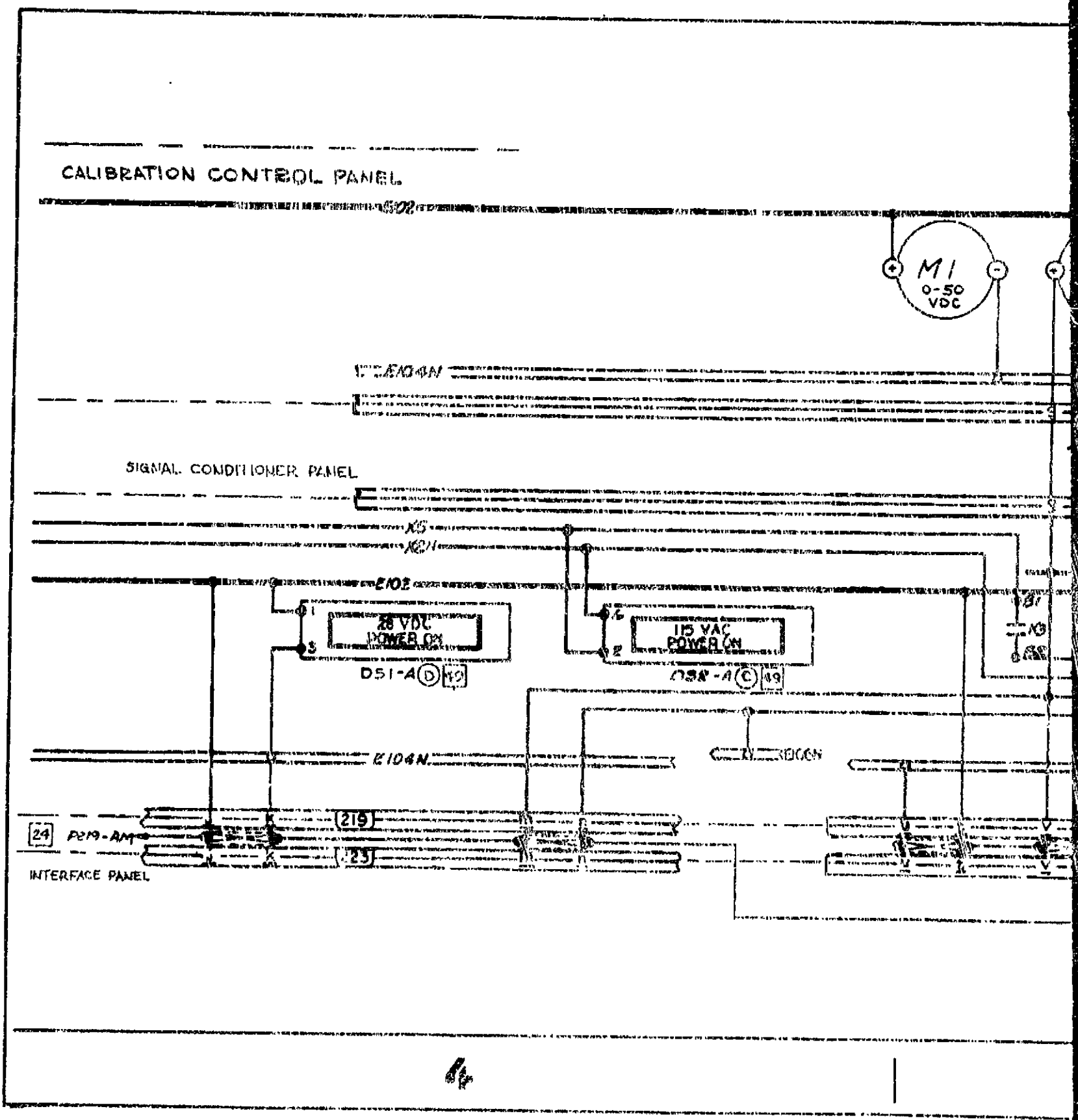
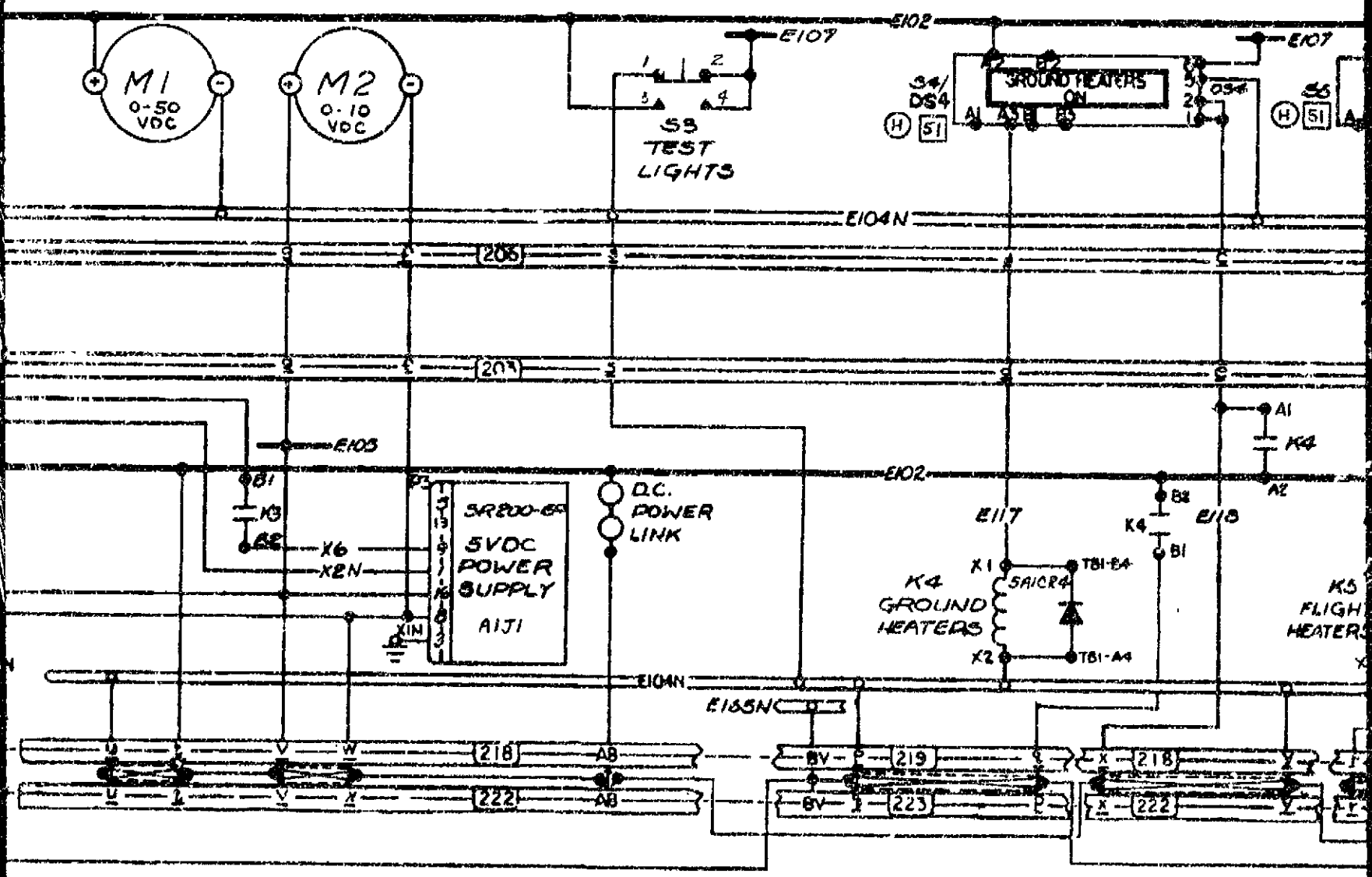


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 1 of 16)


CALIBRATION CONTROL PANEL
M1
0-50
VDC
SIGNAL CONDITIONER PANEL
28 VDC
POWER ON
115 VAC
POWER ON
D51-A
D
12
C
19
219
25
24
INTERFACE PANEL


M1
0-50
VDC
M2
0-10
VDC
E107
E102
1
2
3
4
S5
TEST
LIGHTS
34/
DS4
51
GROUND HEATERS
ON
E104N
208
207
E103
B1
K3
X6
X2N
XIN
P3
SR200-6C
5VDC
POWER
SUPPLY
A1J1
D.C.
POWER
LINK
A1
K4
A2
B2
E117
E118
K4
B1
X1
TB1-B4
K4
GROUND
HEATERS
SAICR4
X2
TB1-A4
K5
FLIGH
HEATER
E104N
E155NC
218
AB
222
8V
219
223
218
222

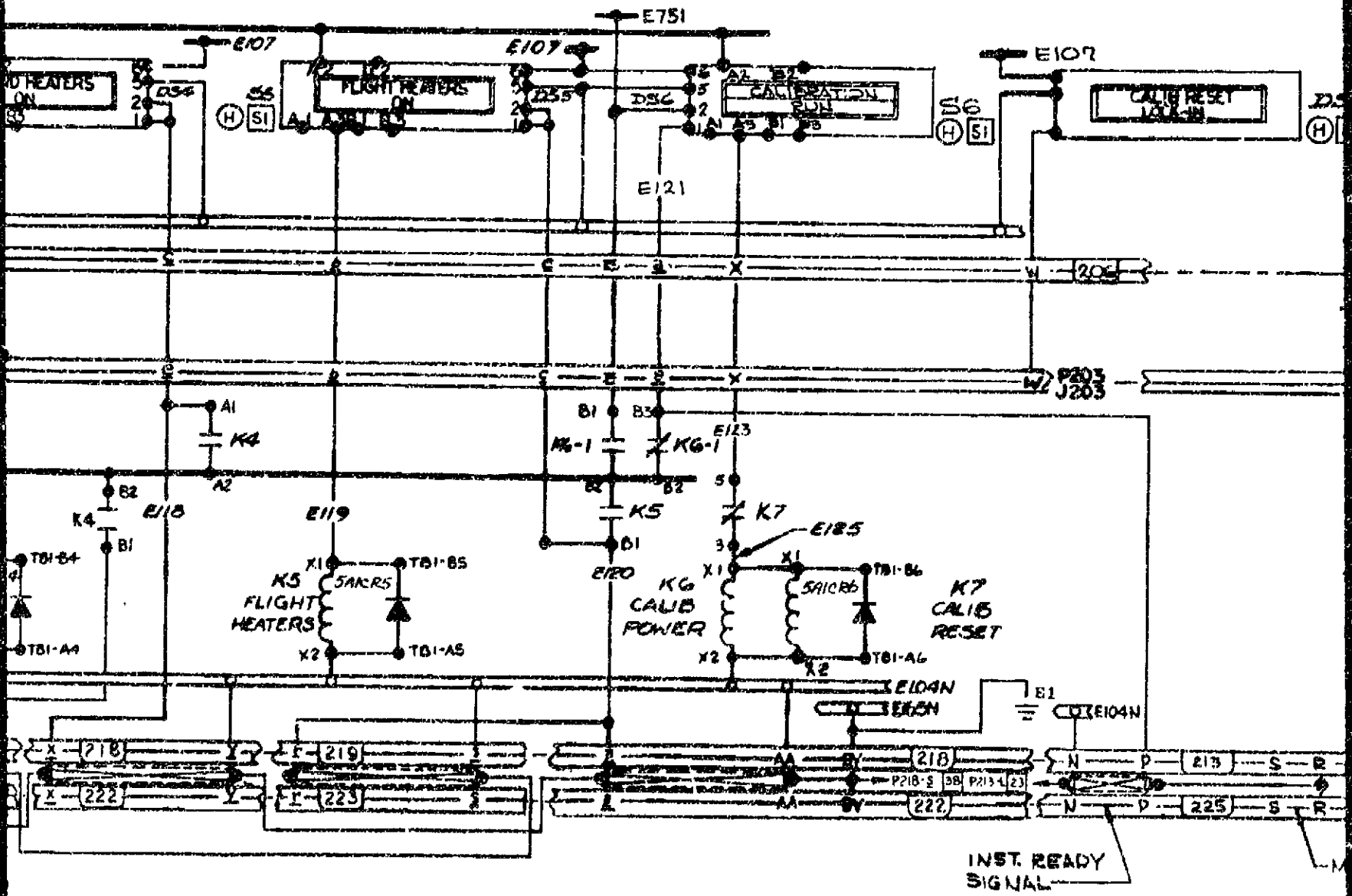


Figure 5-17. Electrical Schematic
Checkout Console (

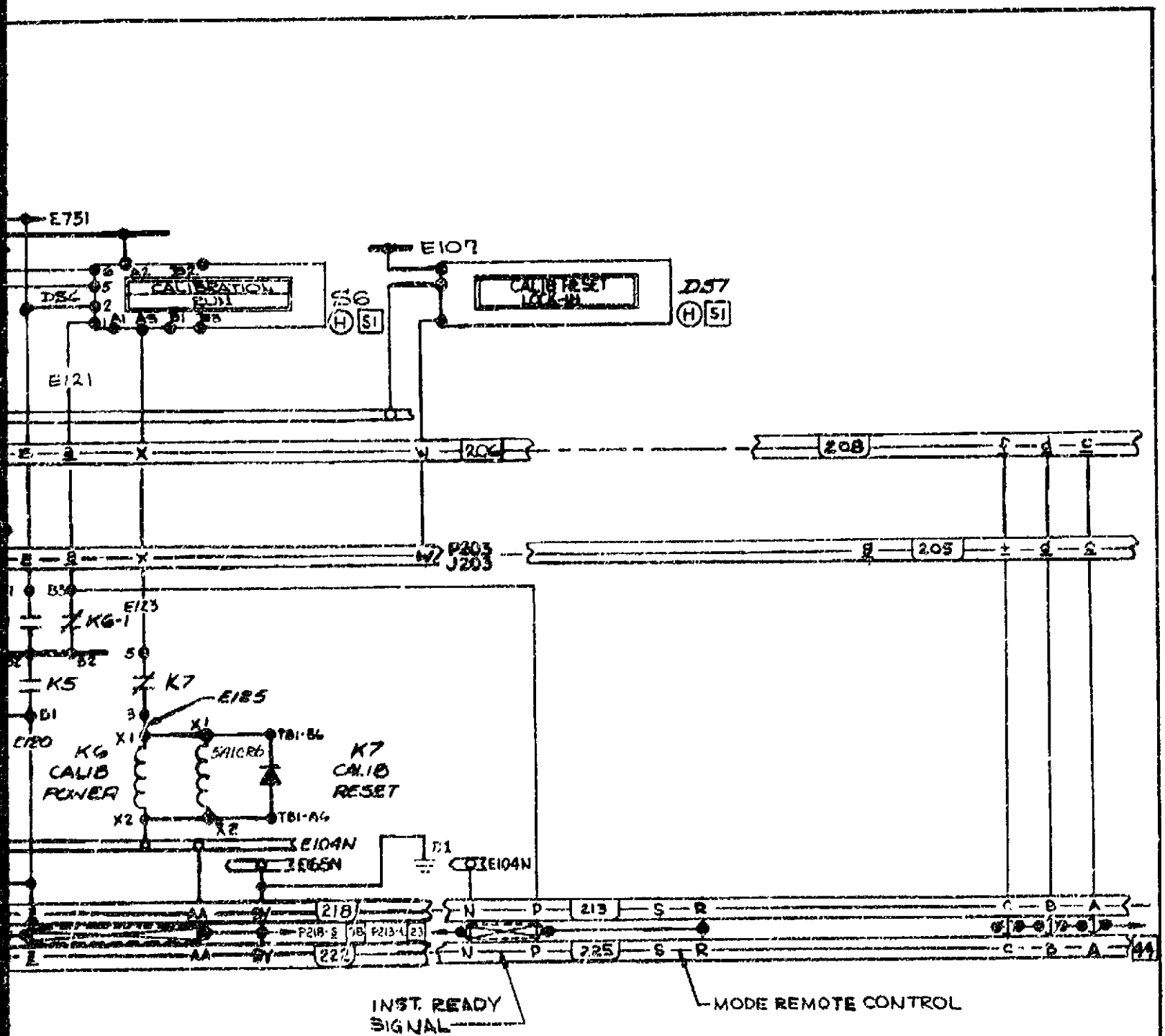
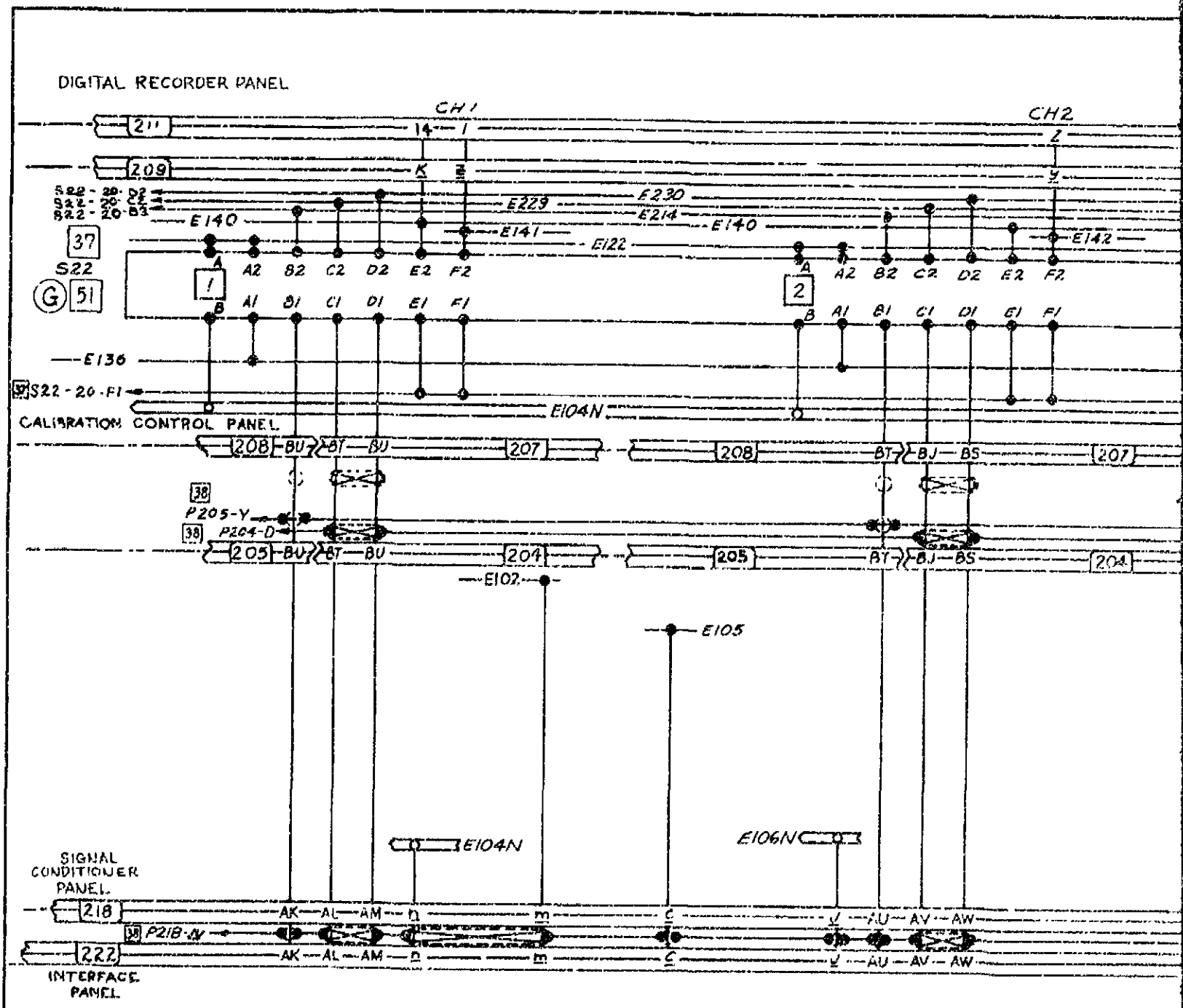
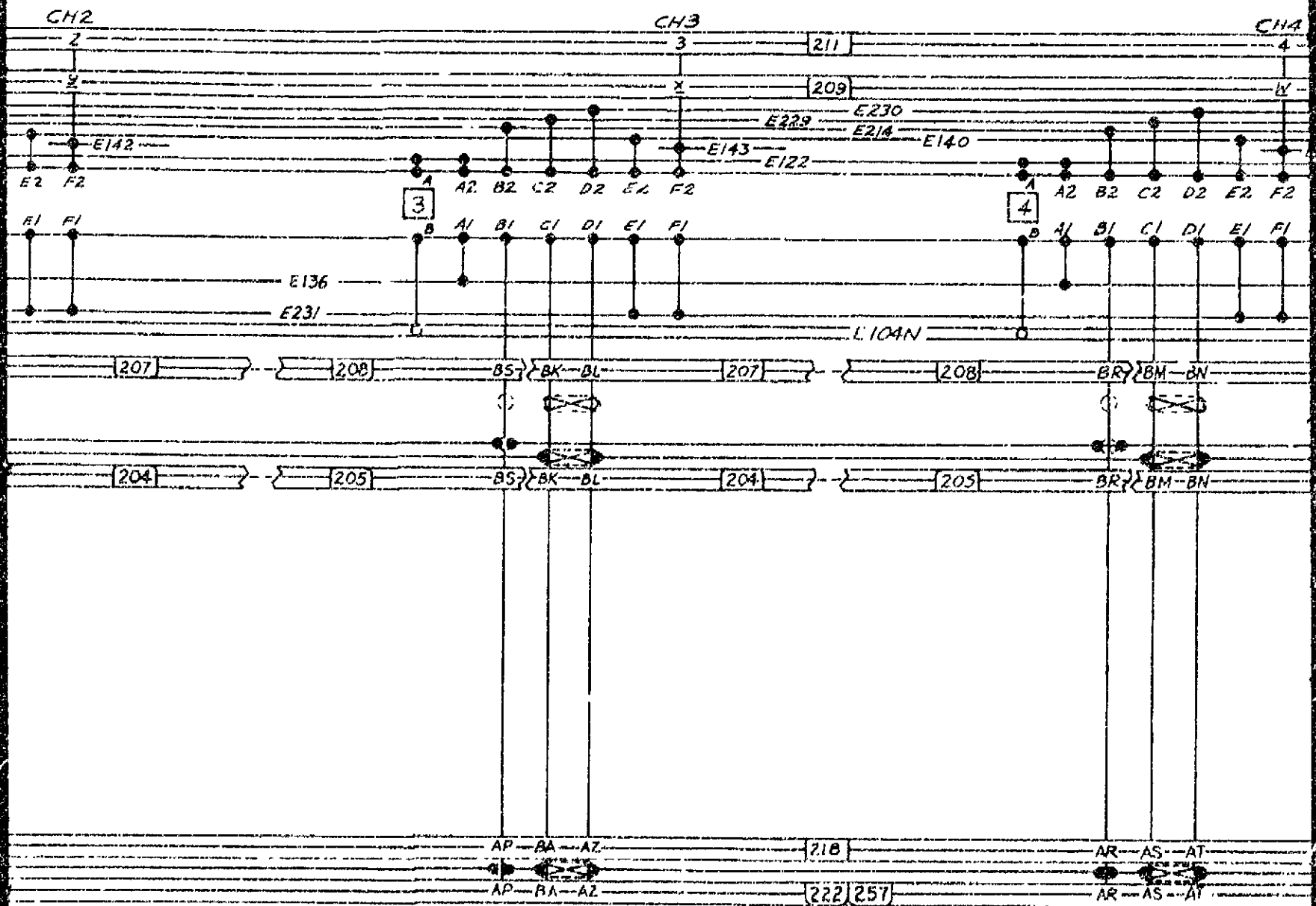
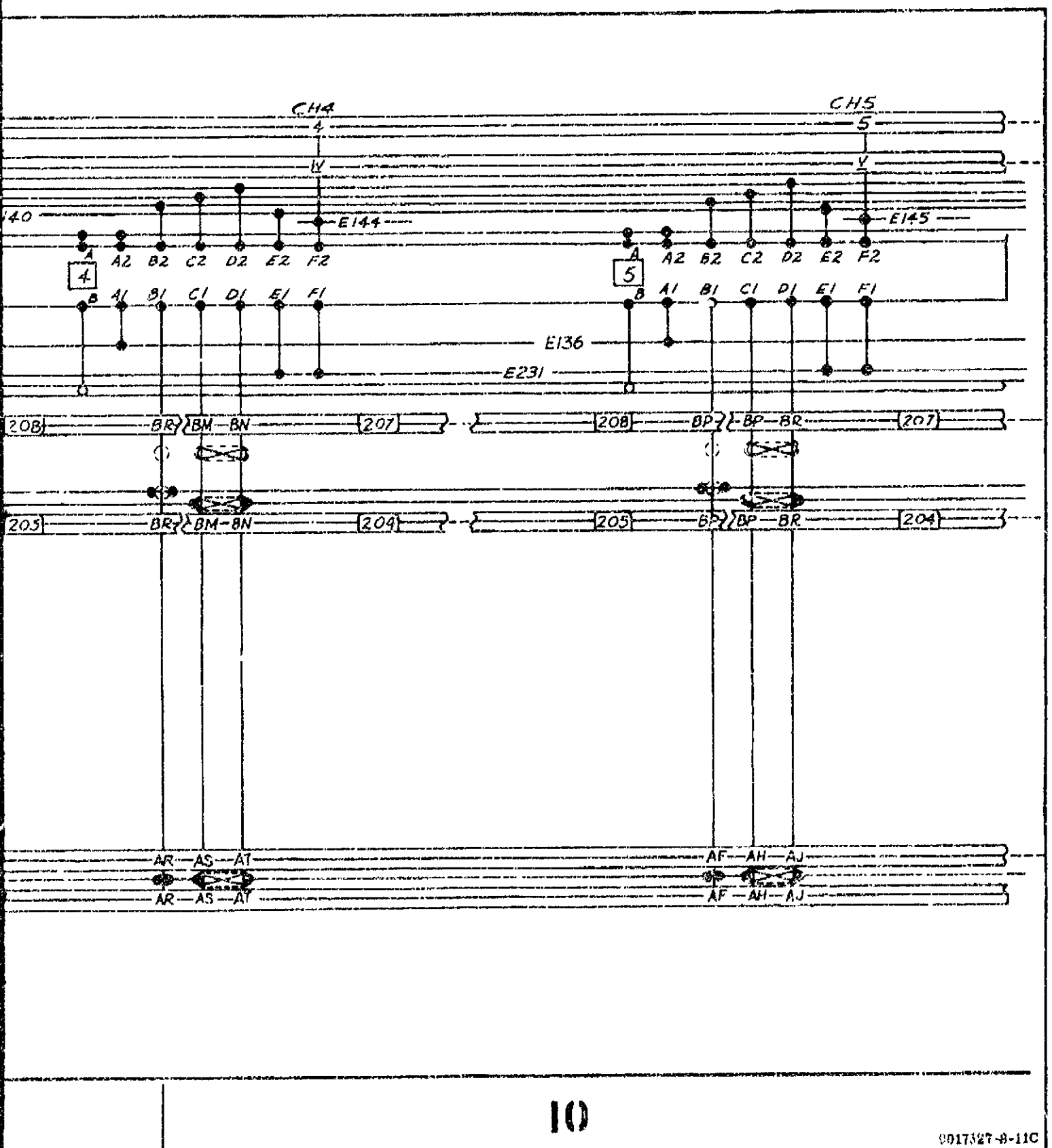


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 2 of 16)


DIGITAL RECORDER PANEL
CH1
CH2
211
209
14
1
Z
K
E
y
S22-20-D2
S22-20-C2
S22-20-B3
E140
E229
E230
E214
E141
E122
E142
37
S22
G
51
A
A2 B2 C2 D2 E2 F2
1
2
B
A1 B1 C1 D1 E1 F1
E136
37 S22-20-F1
E104N
CALIBRATION CONTROL PANEL
208 BU BT BU 207
208 BT BJ BS 207
38 P205-Y
38 P204-D
205 BU BT BU 204
205 BT BJ BS 204
E102
E105
E104N
E106N
SIGNAL CONDITIONER PANEL
218
AK AL AM n m C V AU AV AW
38 P218-N
222
AK AL AM n m C V AU AV AW
INTERFACE PANEL


CH2
CH3
CH4
2
3
4
211
209
E142
E143
E122
E230
E229
E214
E140
E136
E231
L104N
207
208
204
205
BS
BK
BL
BR
BM
BN
AP
BA
AZ
AR
AS
AT
218
222
257

Figure



10

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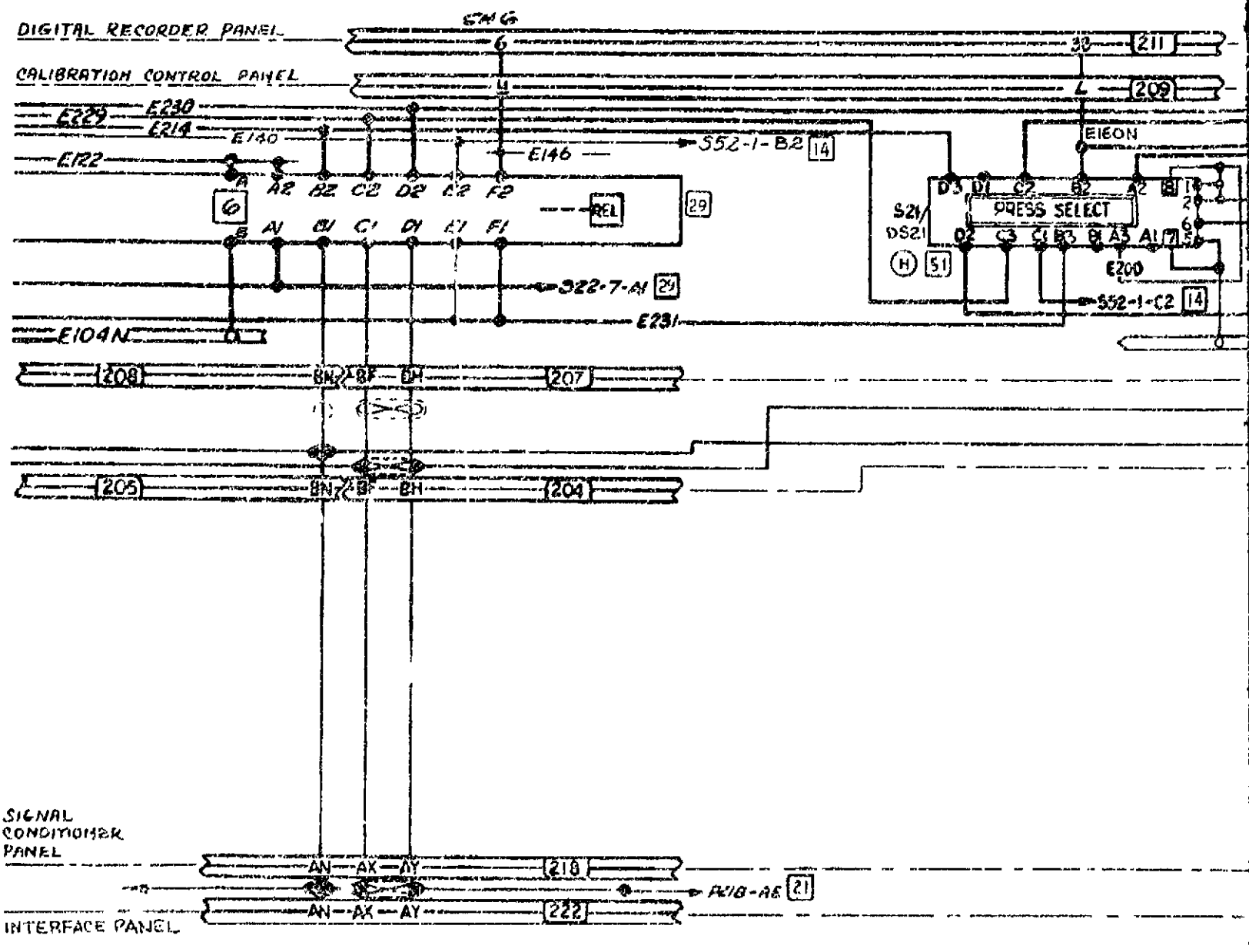
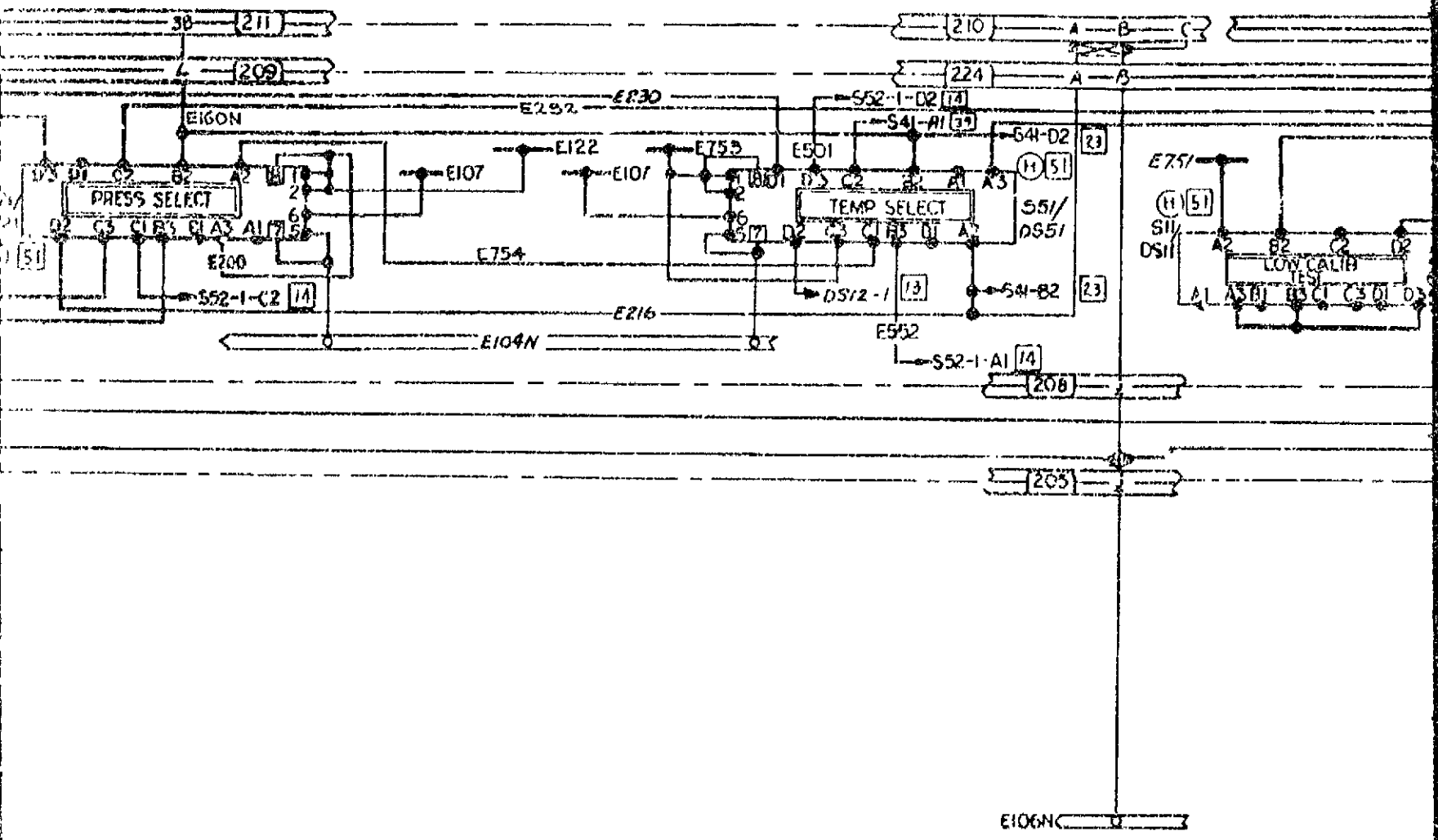
Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 3 of 16)


DIGITAL RECORDER PANEL
CALIBRATION CONTROL PANEL
STM G
E229
E230
E214
E140
E122
E146
552-1-B2 14
E231
E104N
322-7-A1 29
REL 29
208
207
205
204
SIGNAL CONDITIONER PANEL
INTERFACE PANEL
AN AX AY 218
AN AX AY 222
A418-AE 21
211
209
E180N
PRESS SELECT
S21
DS21
E200
552-1-C2 14
51


38
211
210
209
224
E230
E252
S52-1-D2
E160N
S41-A1
S41-D2
E122
E753
E501
E751
E107
E101
PRESS SELECT
TEMP SELECT
S51/
DS51
S11/
DS11
LOW CALIB
TEST
E754
E200
S52-1-C2
DS12-1
S41-B2
E216
E952
S52-1-A1
208
205
E104N
E106N

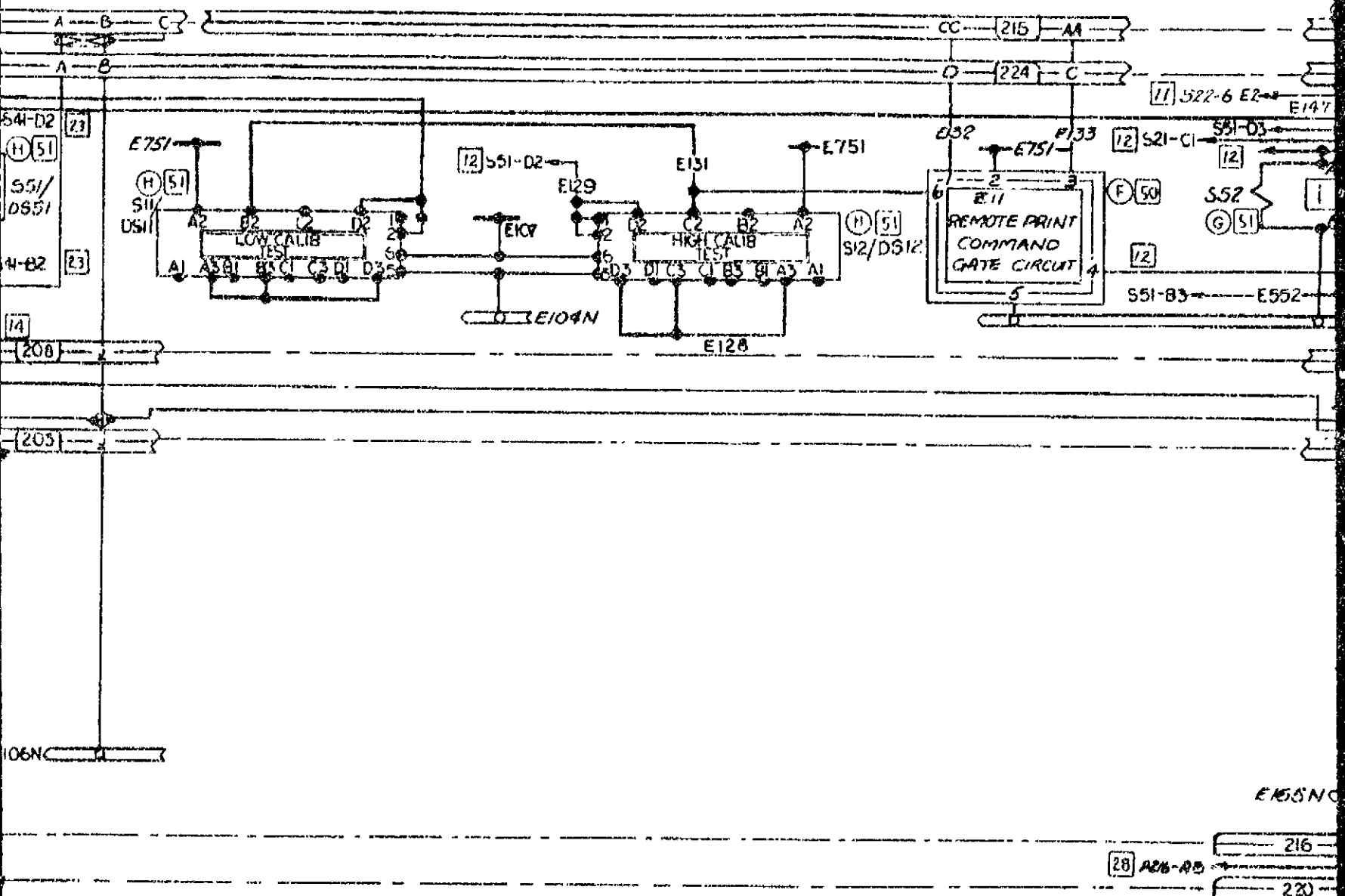


Figure 5-17. Electrical S
Checkout C

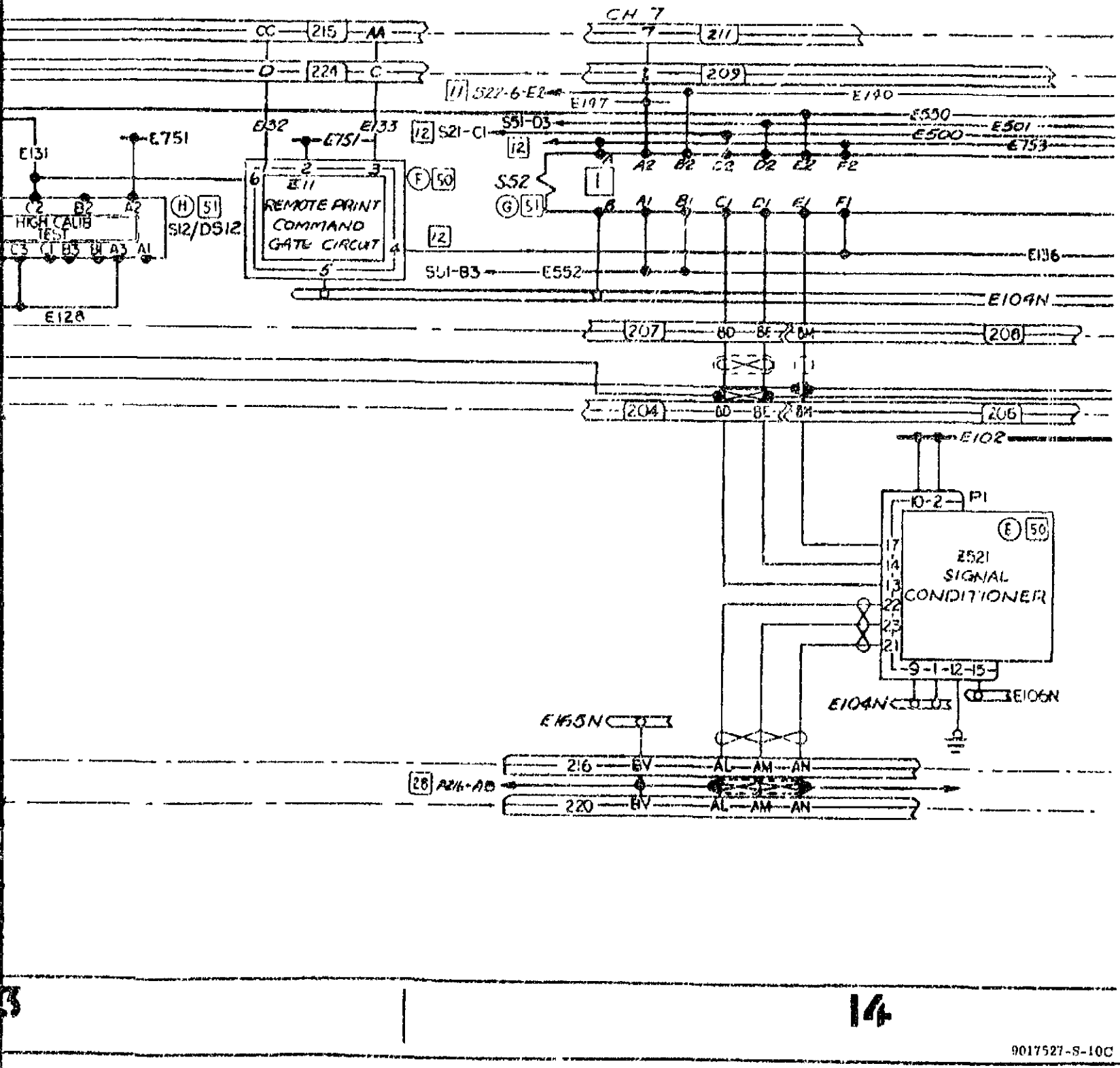


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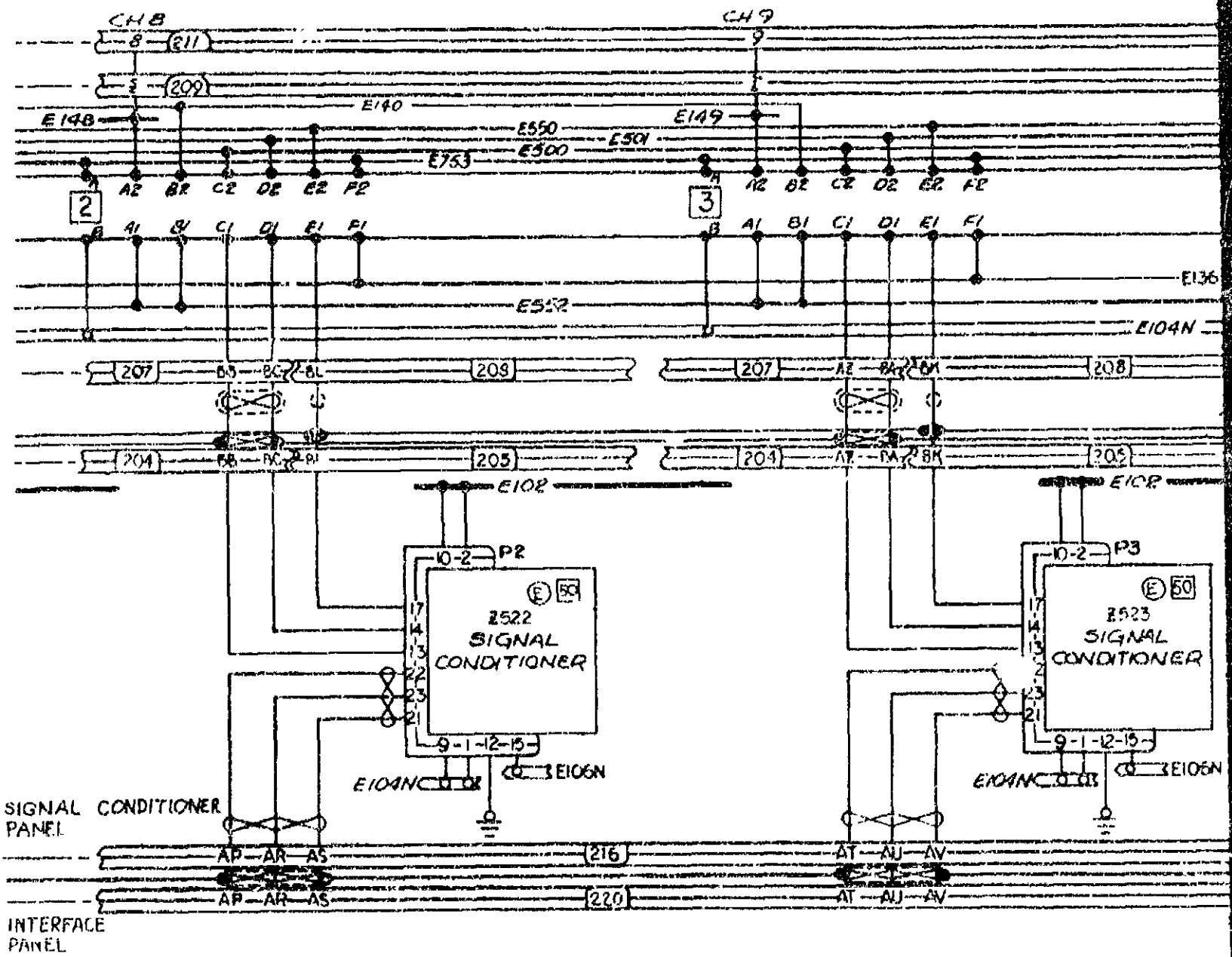
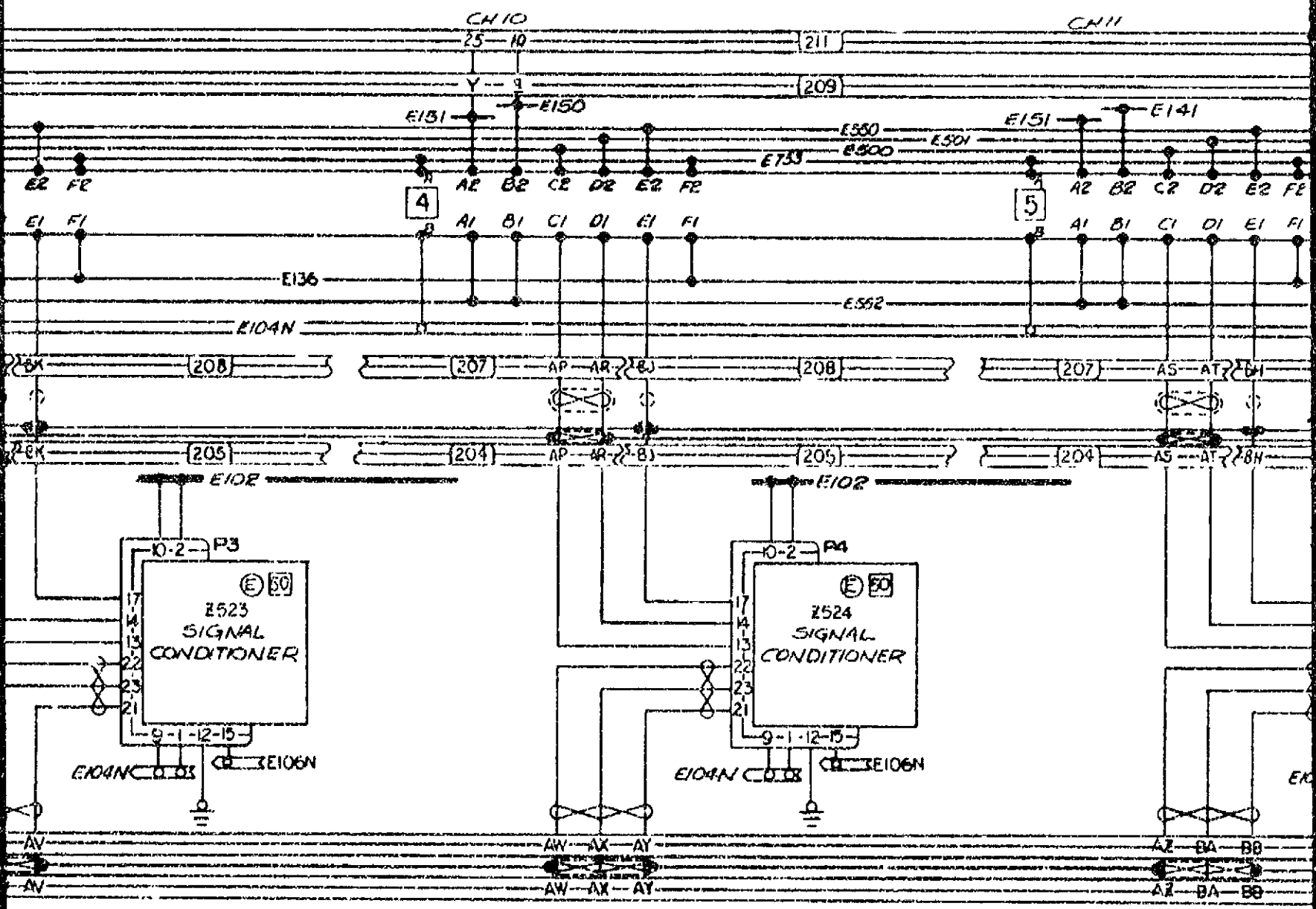
Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 4 of 16)


CH B
CH 9
E148
E140
E149
E550
E501
E500
E753
E136
E104N
E102
E108
P2
P3
2522
SIGNAL
CONDITIONER
2523
SIGNAL
CONDITIONER
E104NC
E106N
SIGNAL CONDITIONER
PANEL
INTERFACE
PANEL


CH 10
CH 11
25
10
211
209
E150
E151
E141
E560
E501
E733
E500
E136
E562
E104N
208
207
205
204
E102
P3
P4
E523
SIGNAL
CONDITIONER
E524
SIGNAL
CONDITIONER
E104NC
E106N
E104N
E106N

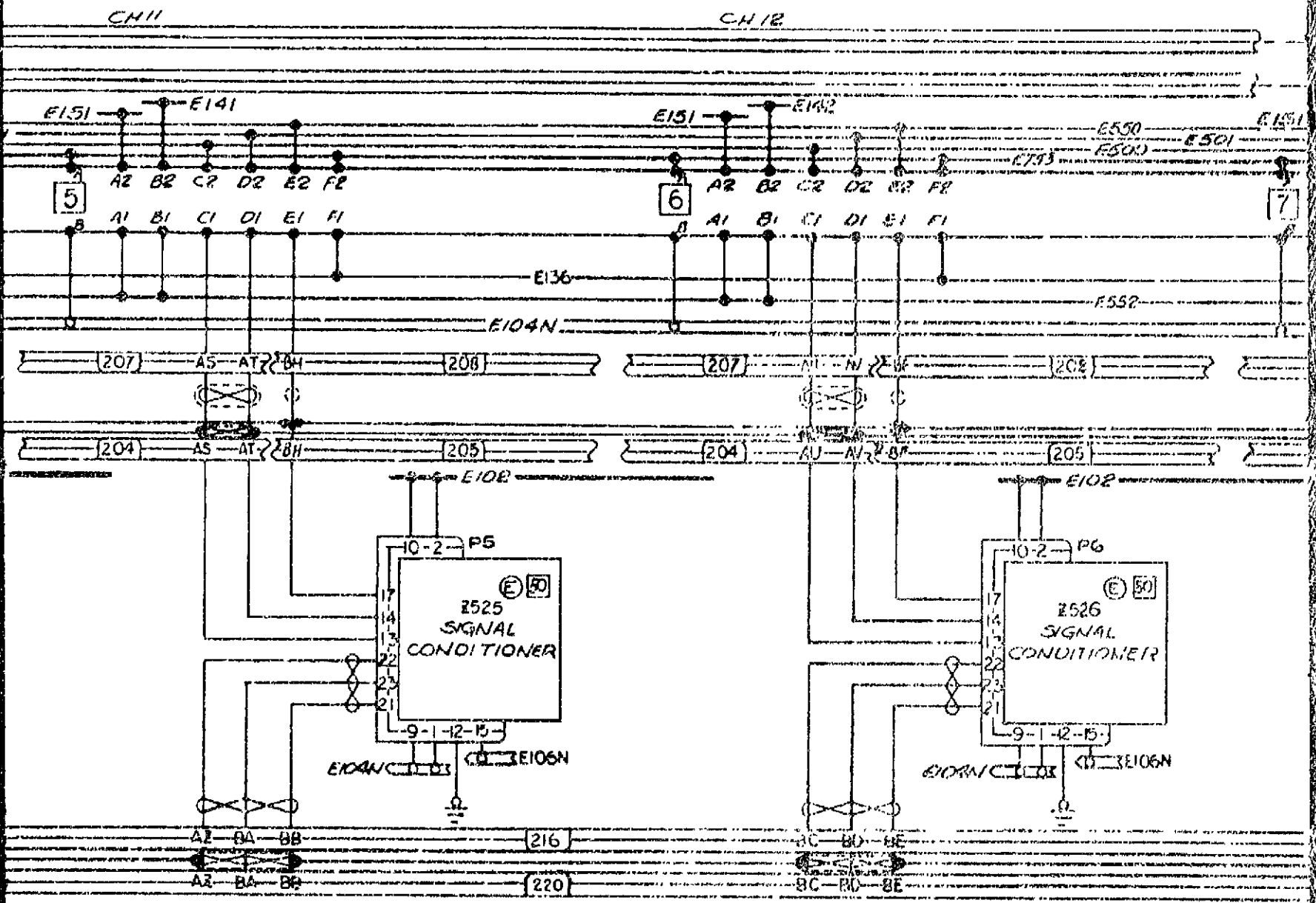


Figure 5-17. Electrical Sel
Checkout Co

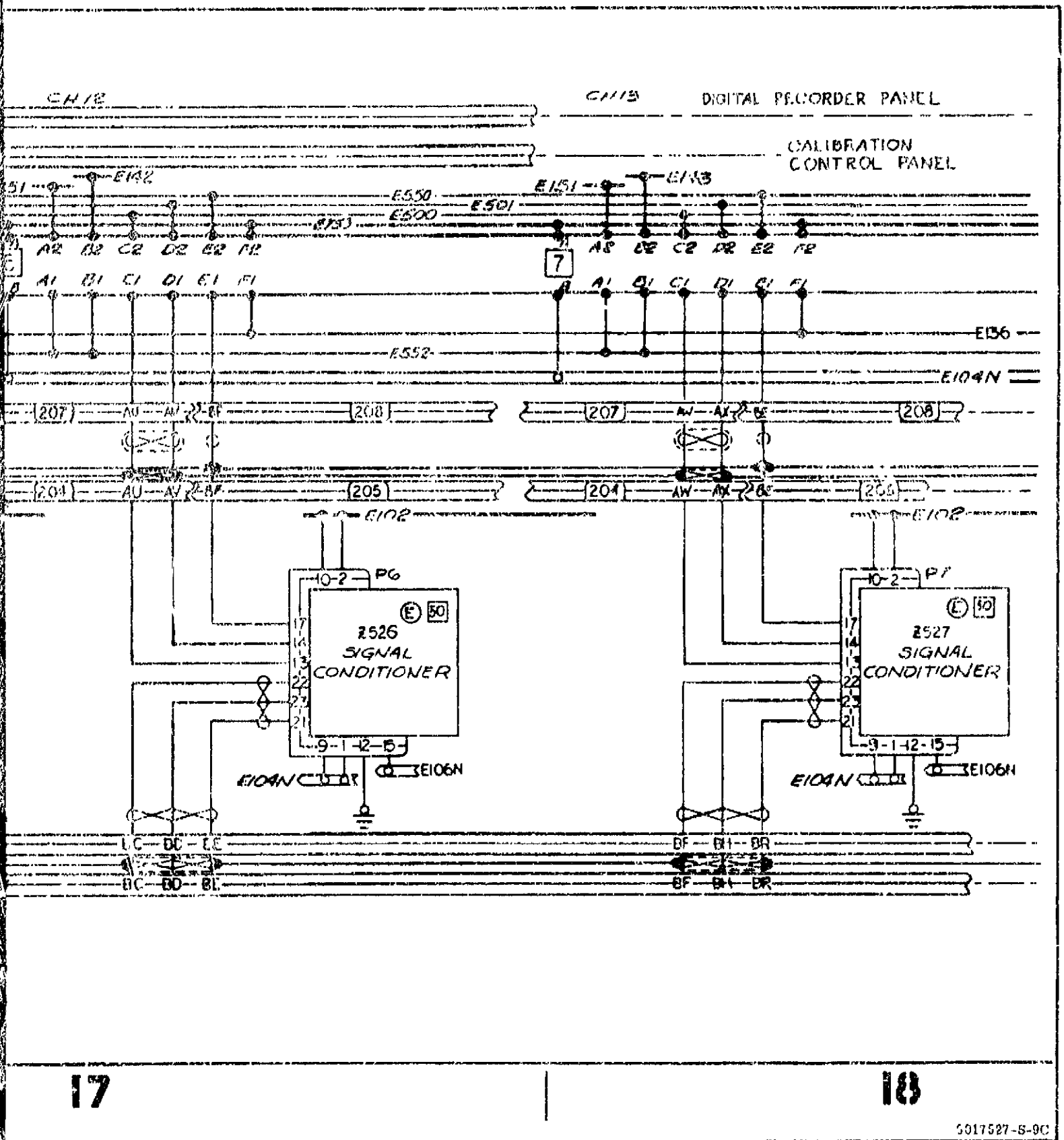
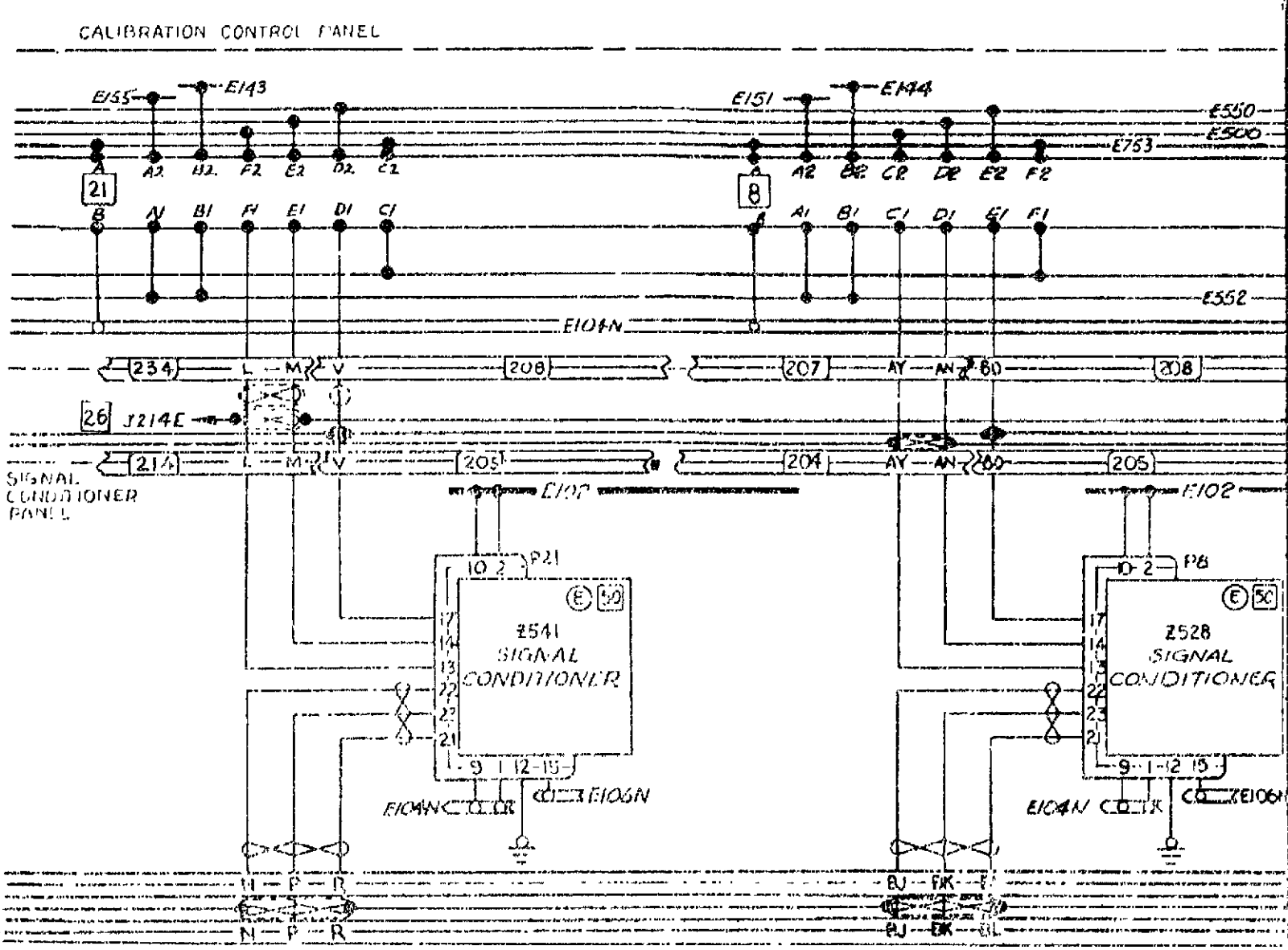
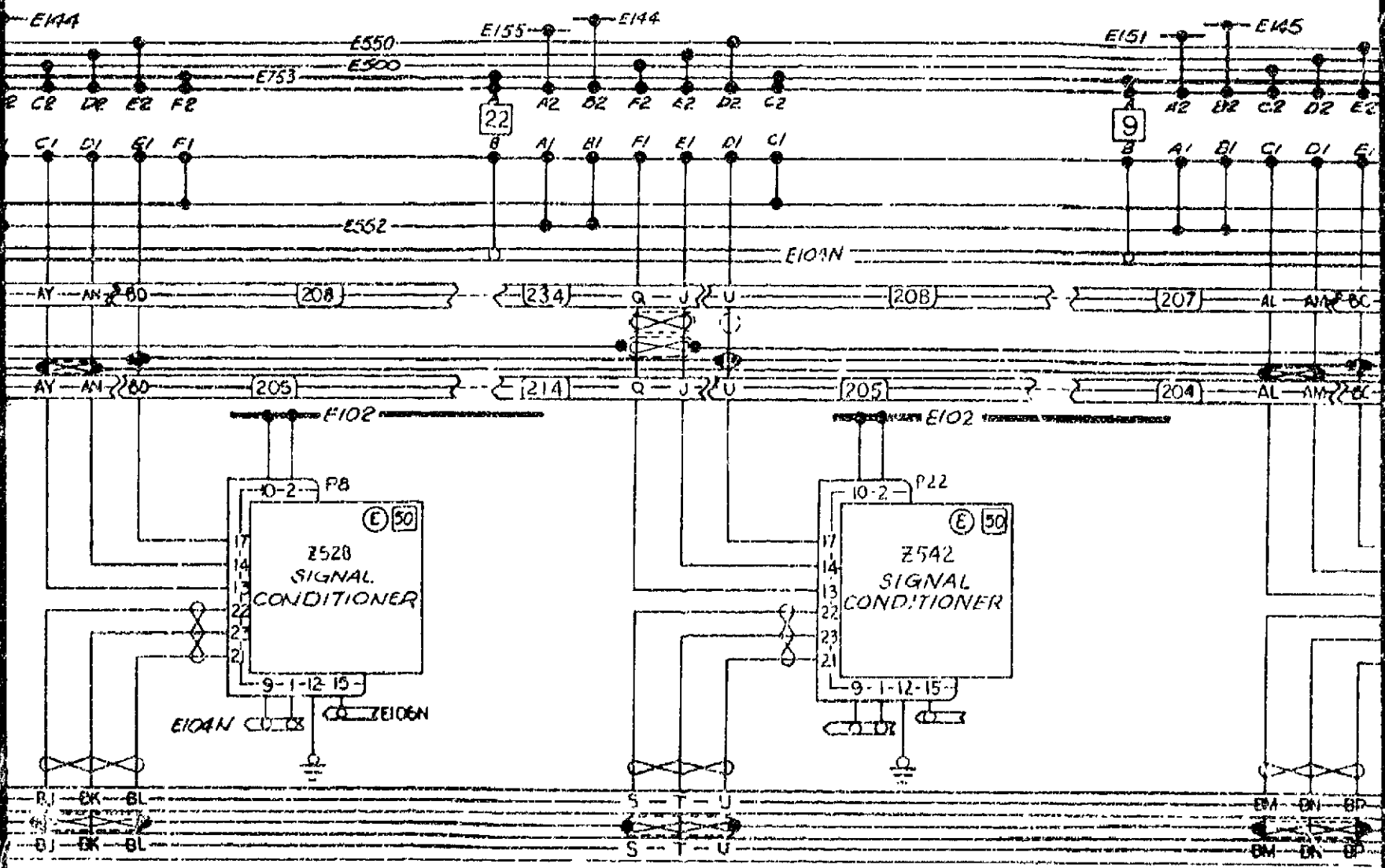


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 5 of 16)


CALIBRATION CONTROL PANEL
E155
E143
E151
E144
E550
E500
E753
E552
E104N
234
208
207
208
26
J214E
214
205
204
205
SIGNAL CONDITIONER PANEL
E101
E102
P21
P8
Z541
SIGNAL CONDITIONER
Z528
SIGNAL CONDITIONER
E104N
E106N
N
P
R
EJ
FJK
EK
EL


E144
E550
E500
E753
E155
E144
E151
E145
22
9
E562
E104N
208
234
208
207
205
214
205
204
E102
E102
P8
P22
10-2
10-2
Z528
SIGNAL
CONDITIONER
Z542
SIGNAL
CONDITIONER
9-1-12-15
9-1-12-15
E104N
ZE106N

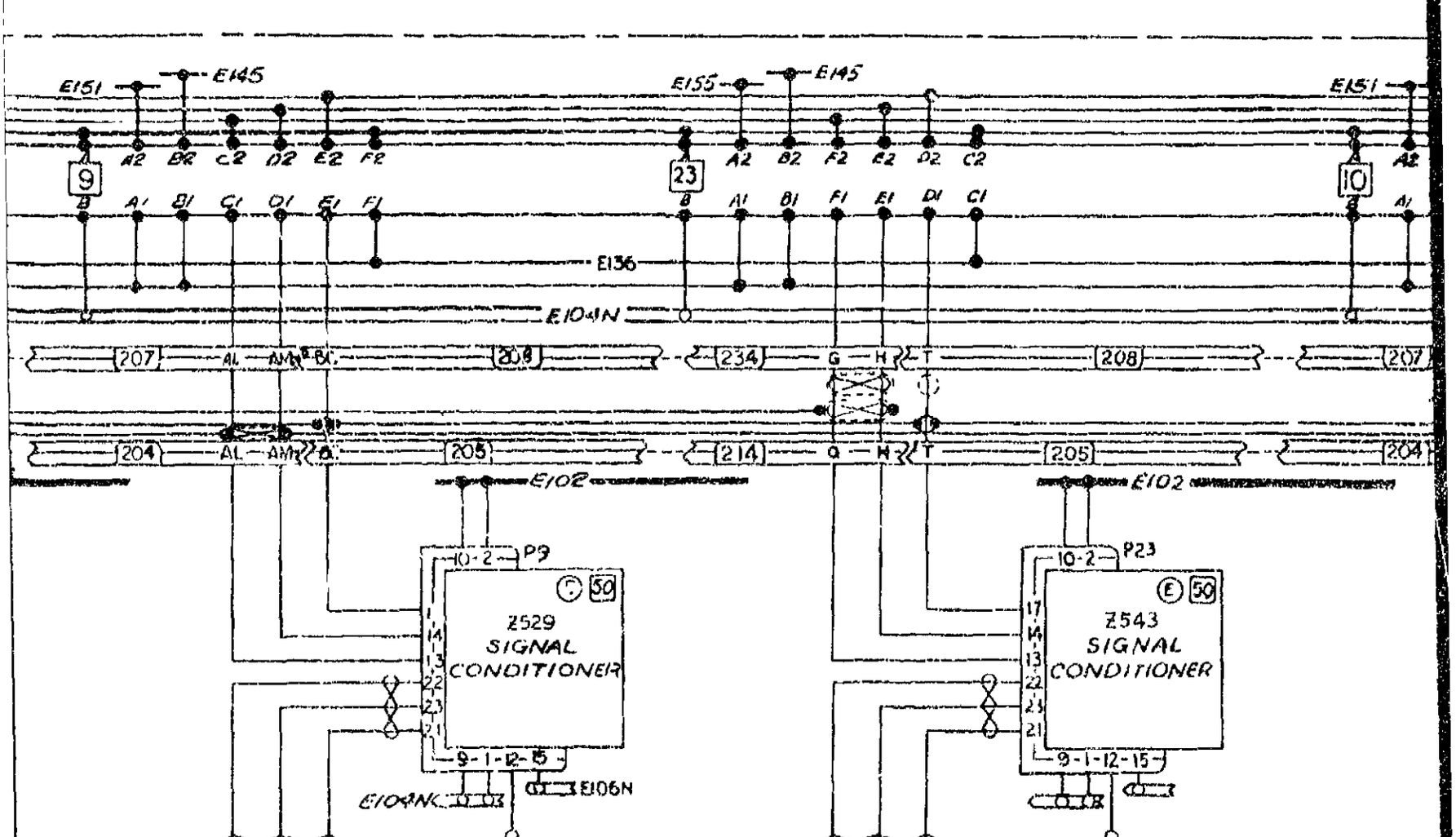


Figure 5-17. Electrical S
Checkout (

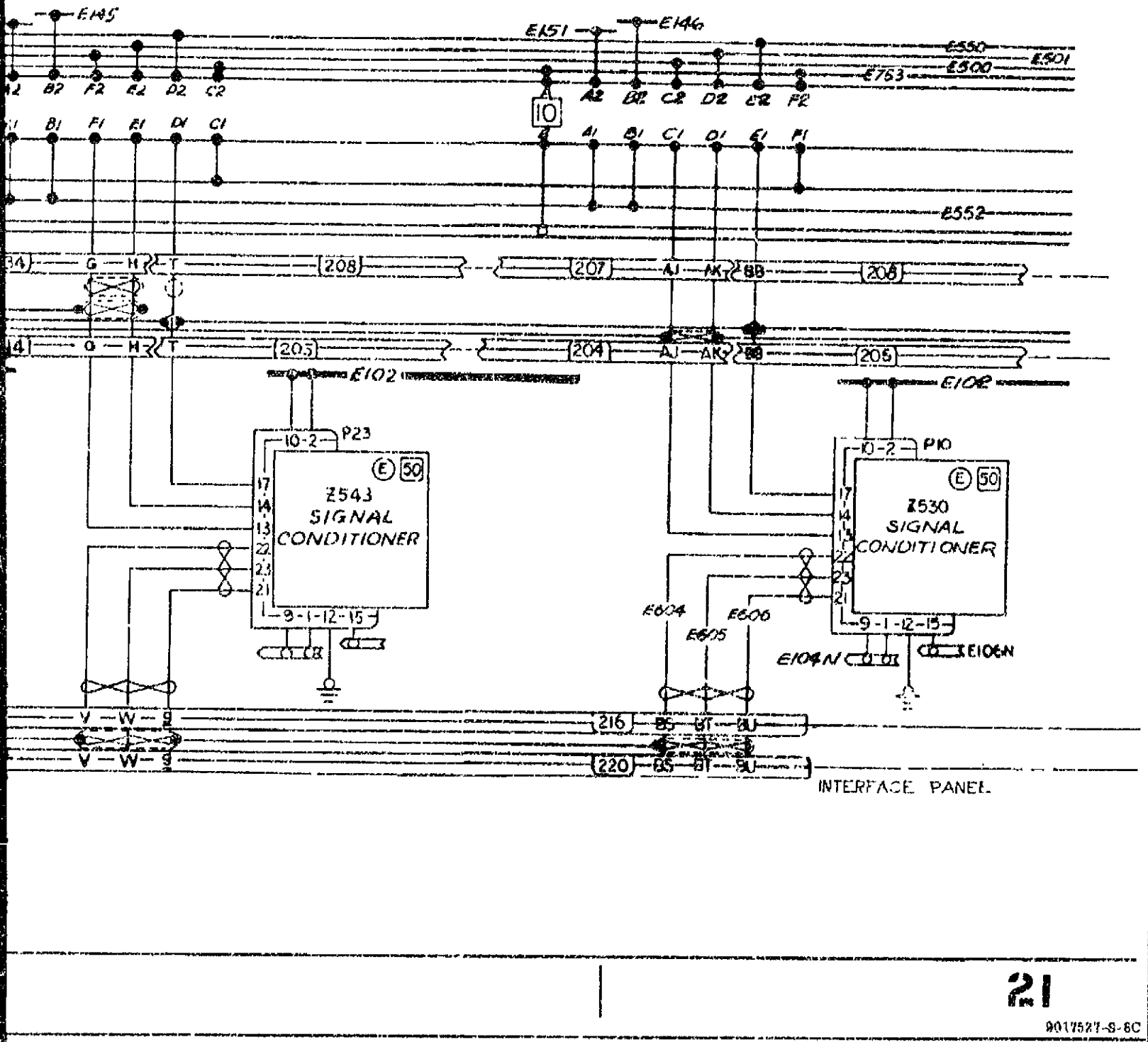


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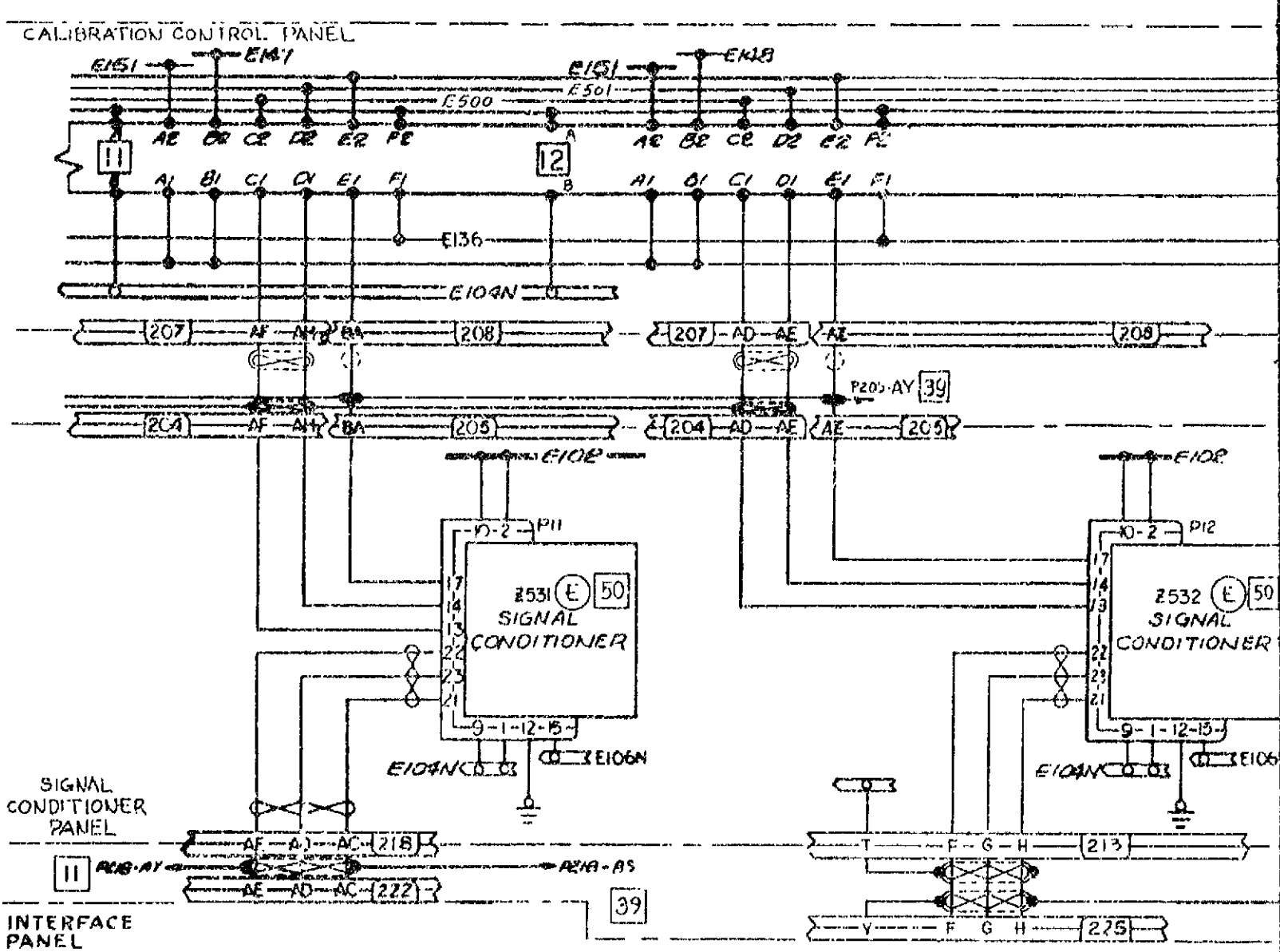
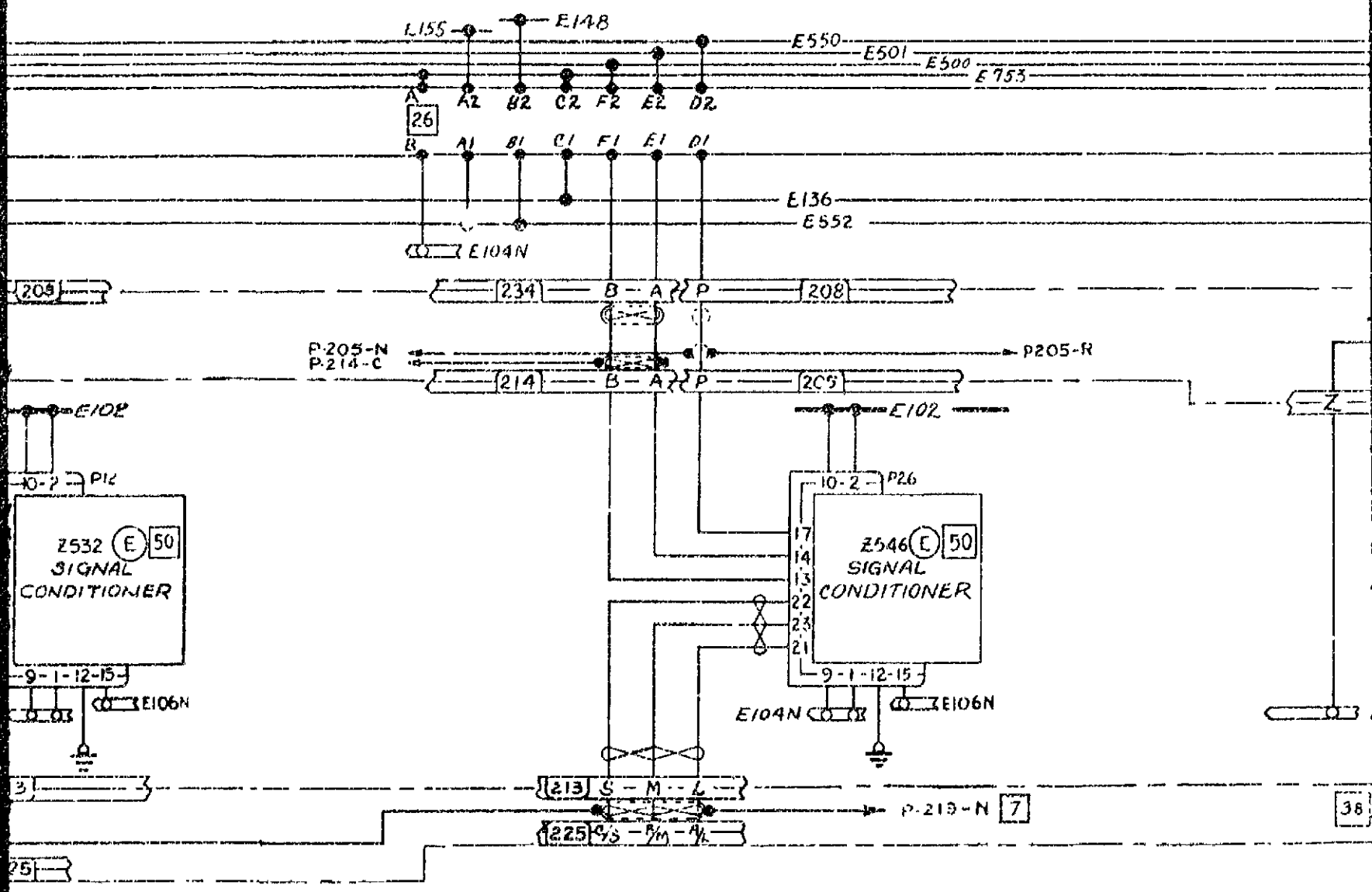
Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 6 of 16)


CALIBRATION CONTROL PANEL
E151
EM1
E500
E501
E151
EM2
E136
E104N
207
208
204
205
P205-AY 39
E102
E102
P11
P12
2531 E 50
SIGNAL CONDITIONER
2532 E 50
SIGNAL CONDITIONER
E104N
E106N
E104N
E106
SIGNAL CONDITIONER PANEL
218
222
213
275
P218-A1
P218-A5
39
INTERFACE PANEL


L155
E148
E550
E501
E500
E753
A
A2 B2 C2 F2 E2 D2
26
B
A1 B1 C1 F1 E1 D1
E136
E552
E104N
209
234 B - A P 208
P-205-N
P-214-C
P205-R
214 B - A P 209
E102
E102
10-7 P12
Z532 E 50
SIGNAL
CONDITIONER
9-1-12-15
E106N
10-2 P26
17
14
13
22
23
21
Z546 E 50
SIGNAL
CONDITIONER
9-1-12-15
E104N
E106N
Z
213 S - M - L
P-213-N 7
225 S/S - P/M - A/L
38
25

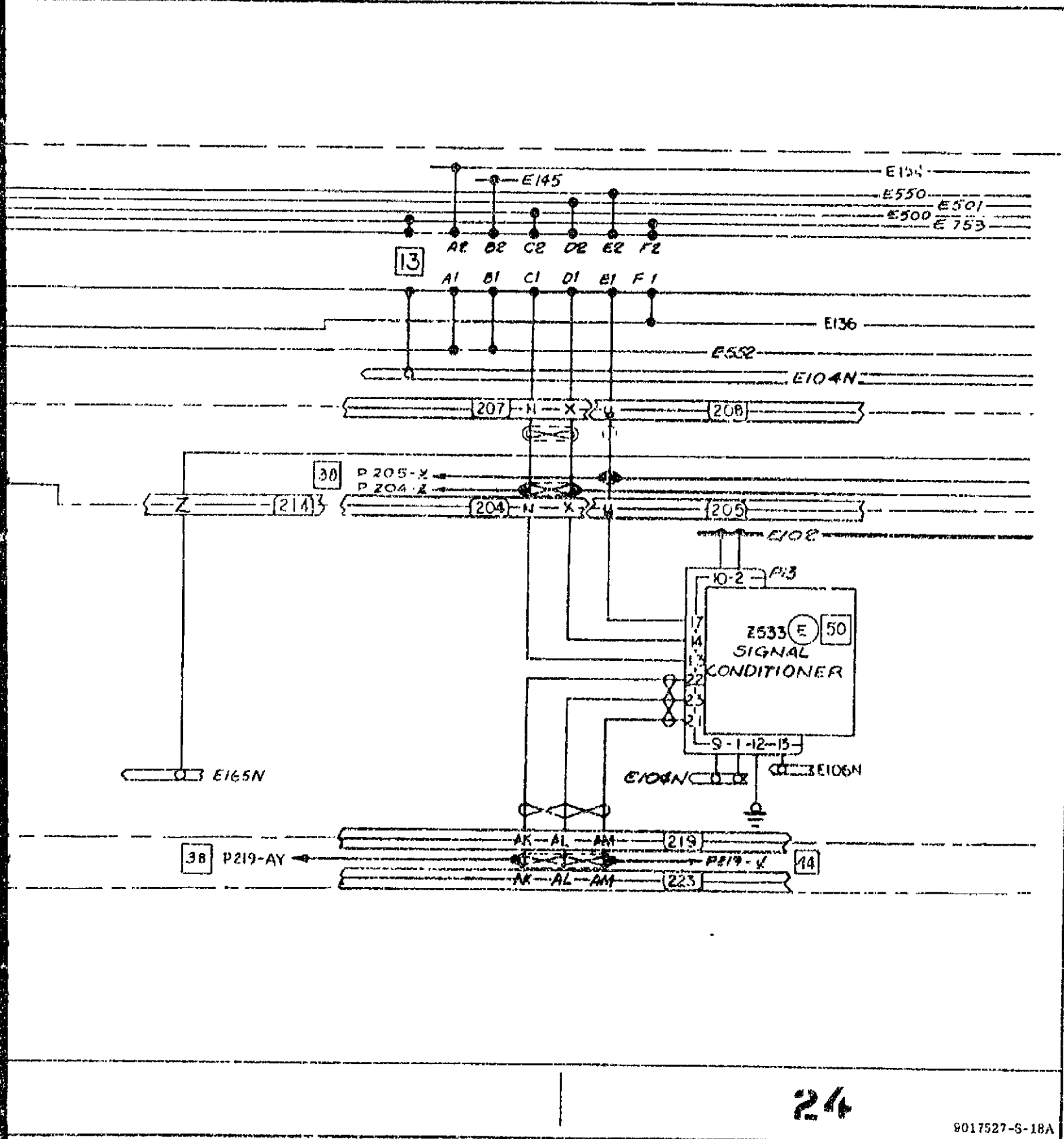
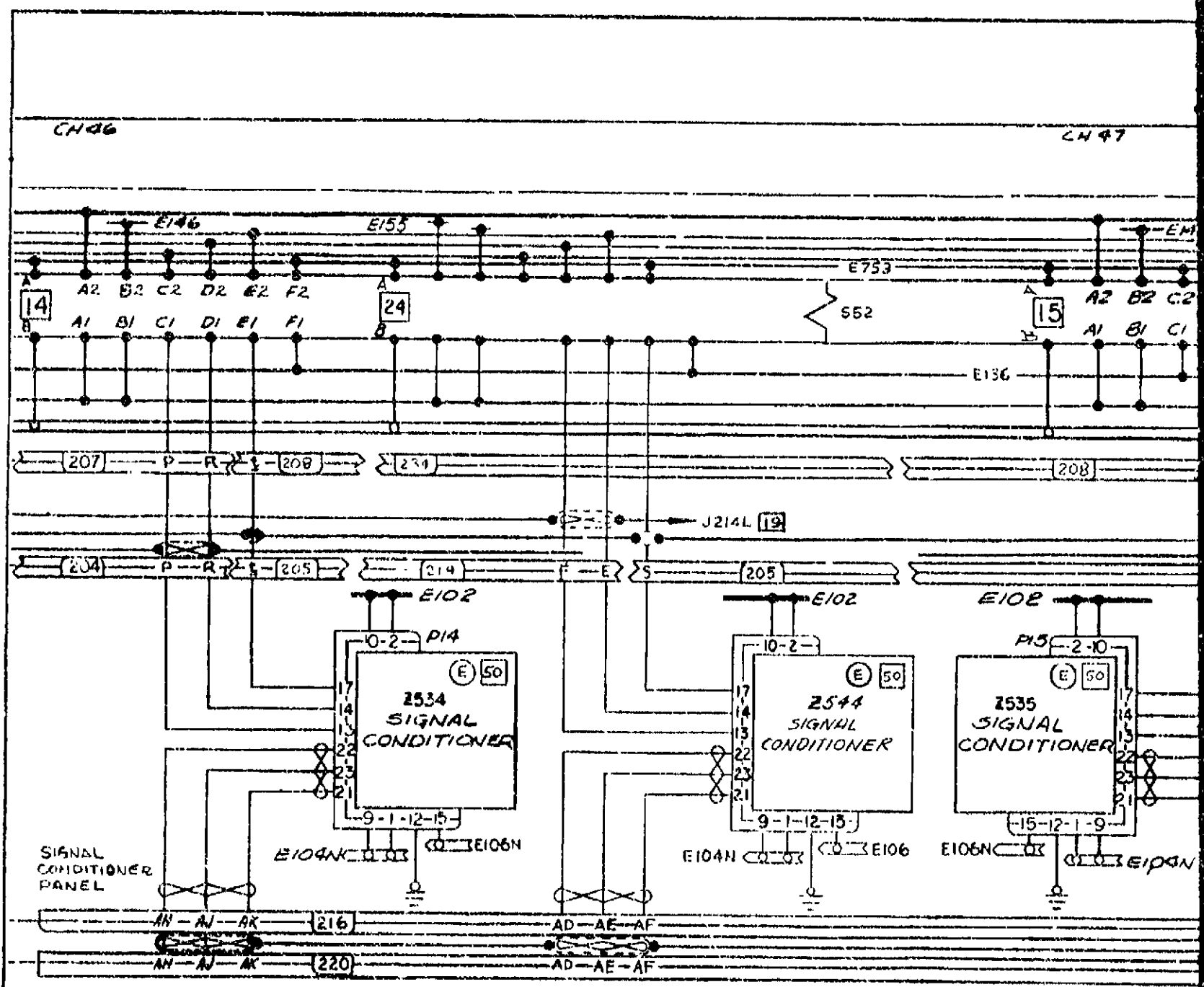
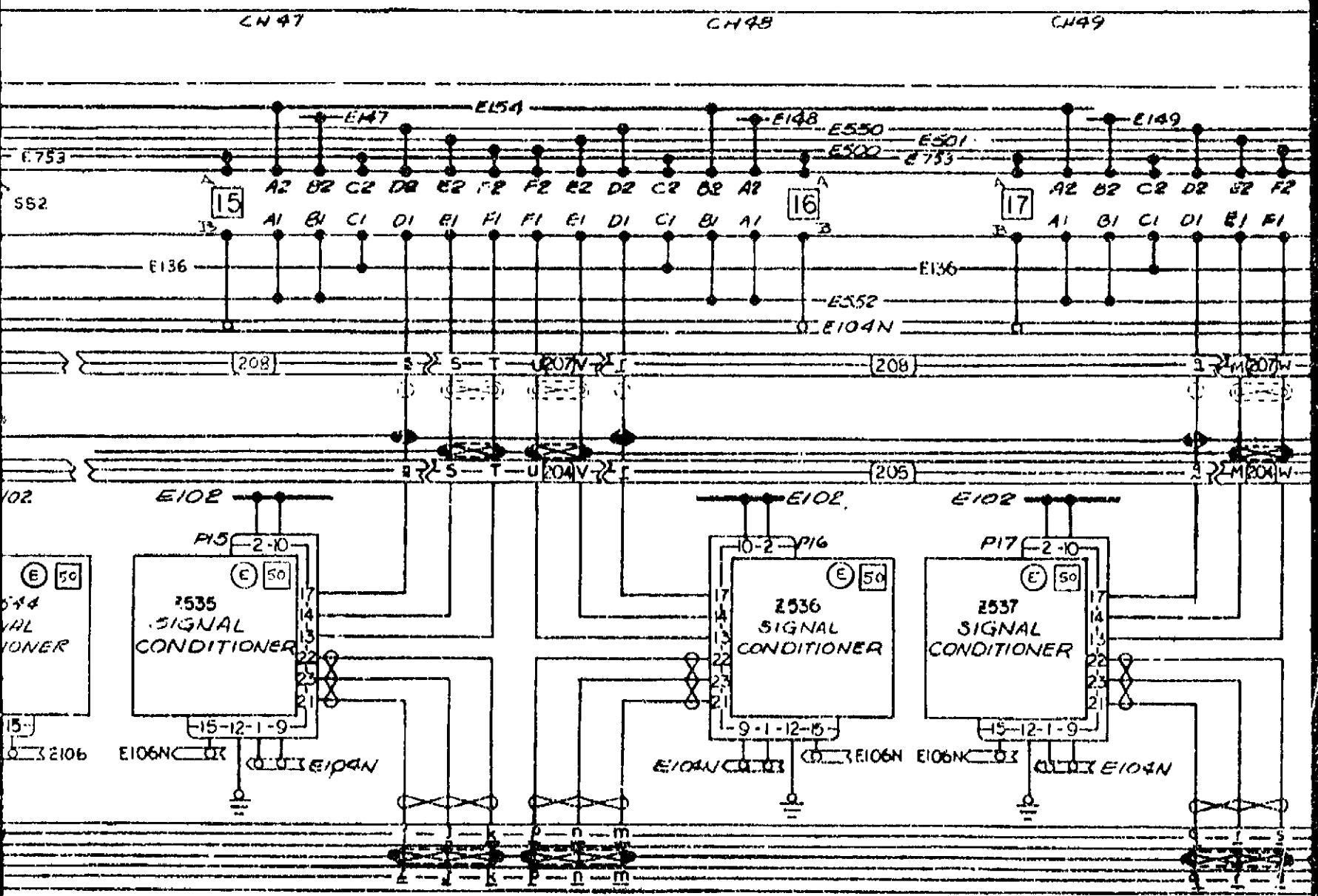
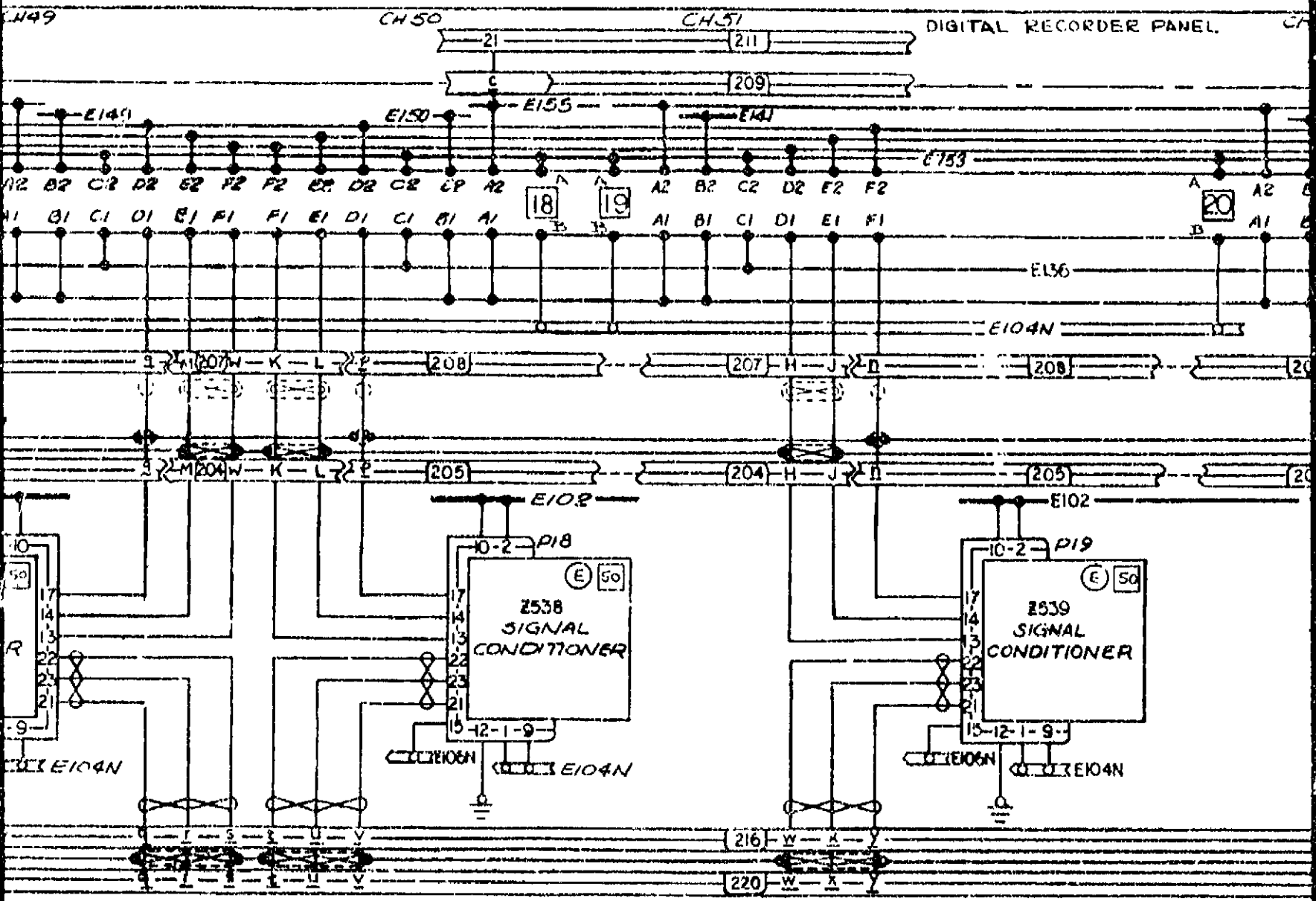


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 7 of 16)


CH 46
CH 47
E146
E153
E753
552
E136
14
24
15
207
208
234
J214L
19
204
205
214
E102
E102
E102
P14
P15
2534
SIGNAL
CONDITIONER
2544
SIGNAL
CONDITIONER
2535
SIGNAL
CONDITIONER
E104NK
E106N
E104N
E106
E106N
E104N
SIGNAL
CONDITIONER
PANEL
216
220


CH47
CH48
CH49
E154
E147
E148
E550
E501
E502
E753
E149
SS2
15
16
17
A2 B2 C2 D2 E2 F2
A1 B1 C1 D1 E1 F1
E136
E552
E104N
208
207V
207W
205
204V
204W
E102
P15
P16
P17
2-10
2535
SIGNAL
CONDITIONER
2536
2537
50
15-12-1-9
9-1-12-15
E106N
E104N
2106



27

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Figure 5-17. Electrical Schemat
Checkout Console

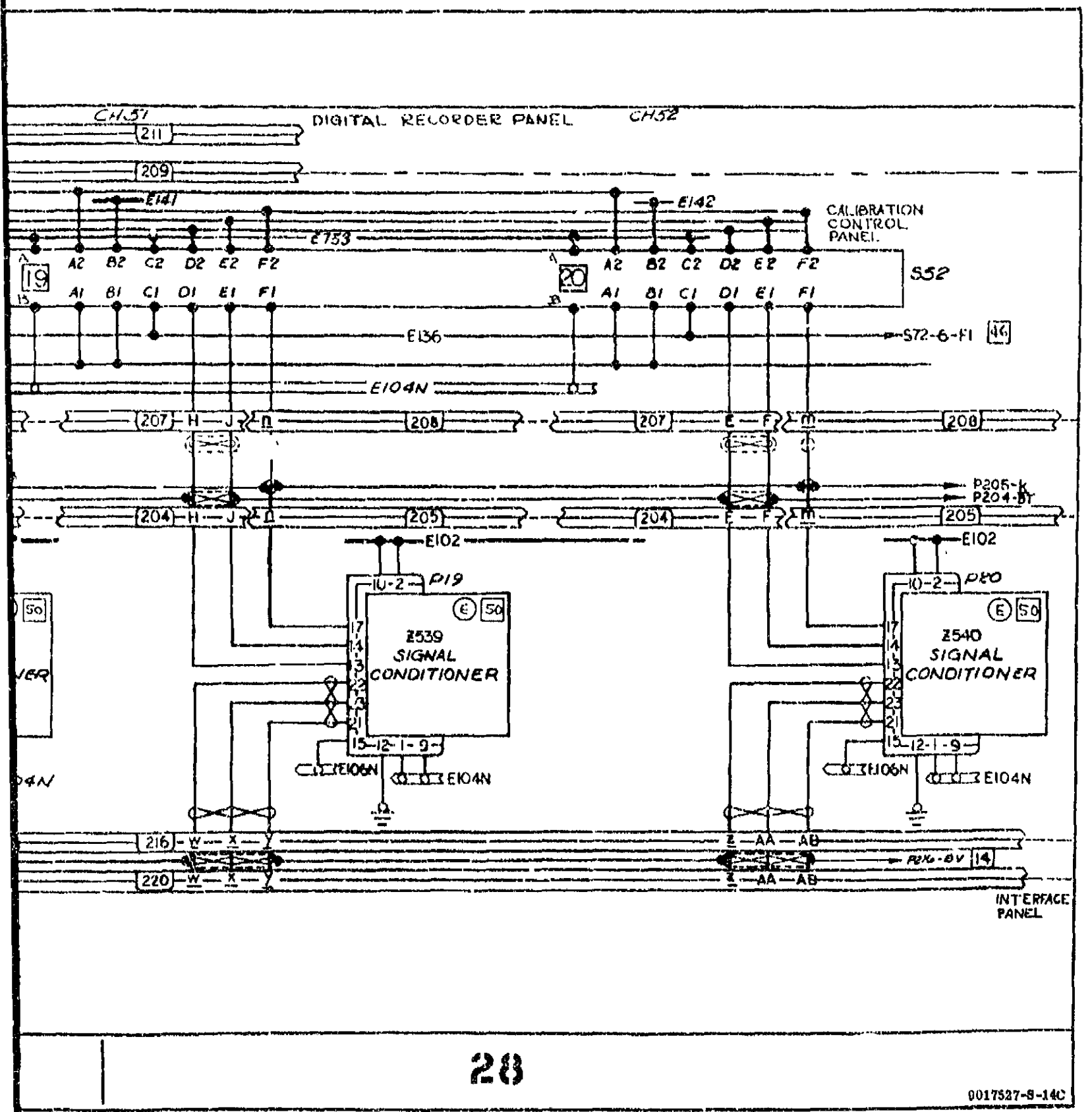
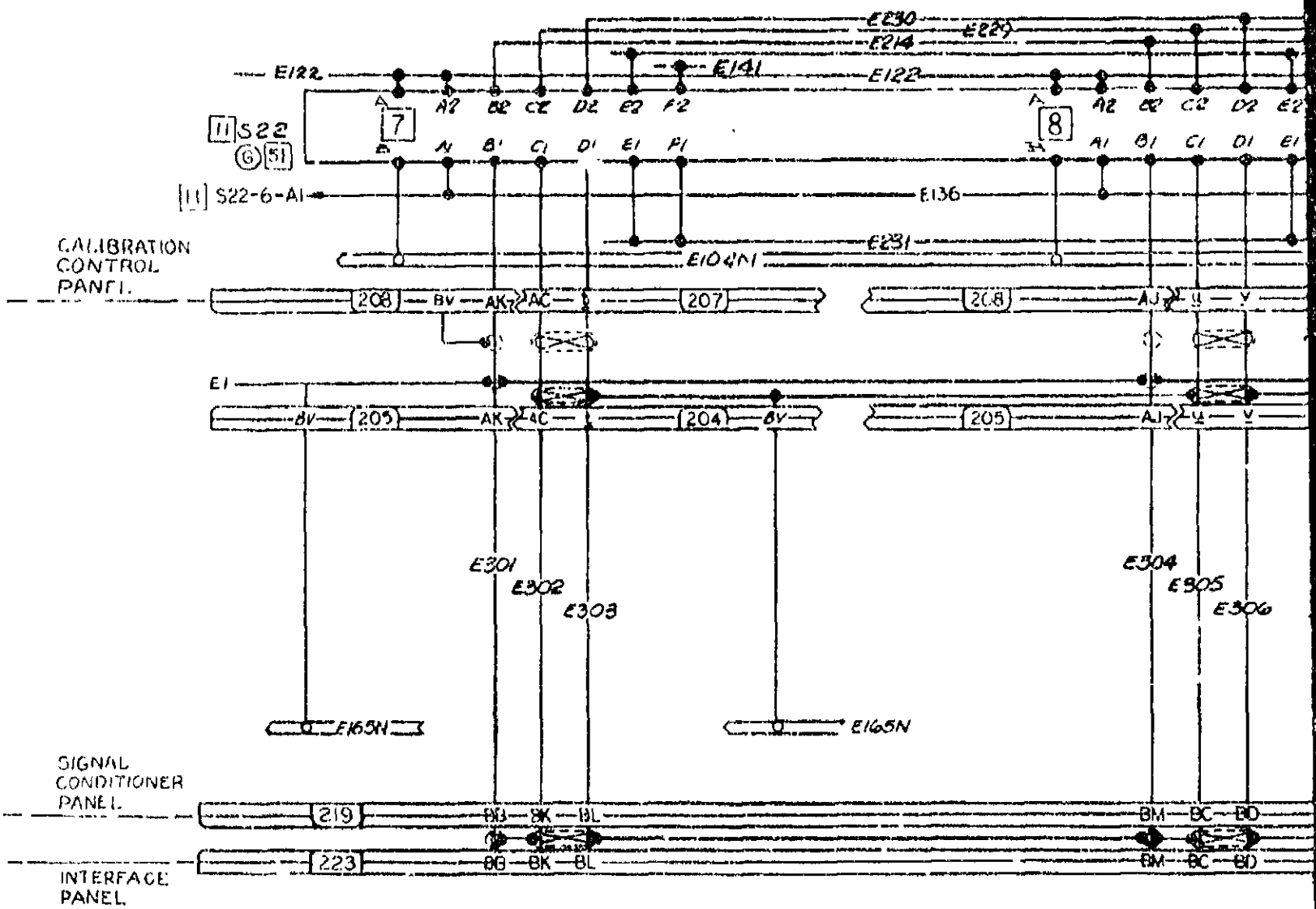


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 8 of 16)


E230
E229
E214
E141
E122
E122
A2 B2 C2 D2 E2 F2
7
8
A2 B2 C2 D2 E2
11 S22
6 51
A1 B1 C1 D1 E1 F1
A1 B1 C1 D1 E1
11 S22-6-A1
E136
E231
E104N1
CALIBRATION CONTROL PANEL
208 BV AK AC 207
208 AJ U V
E1
BV 205 AK AC 204 BV
205 AJ U V
E301
E302
E303
E304
E305
E306
E165N
E165N
SIGNAL CONDITIONER PANEL
219 BJ BK BL BM BC BD
223 BG BK BL BM BC BD
INTERFACE PANEL

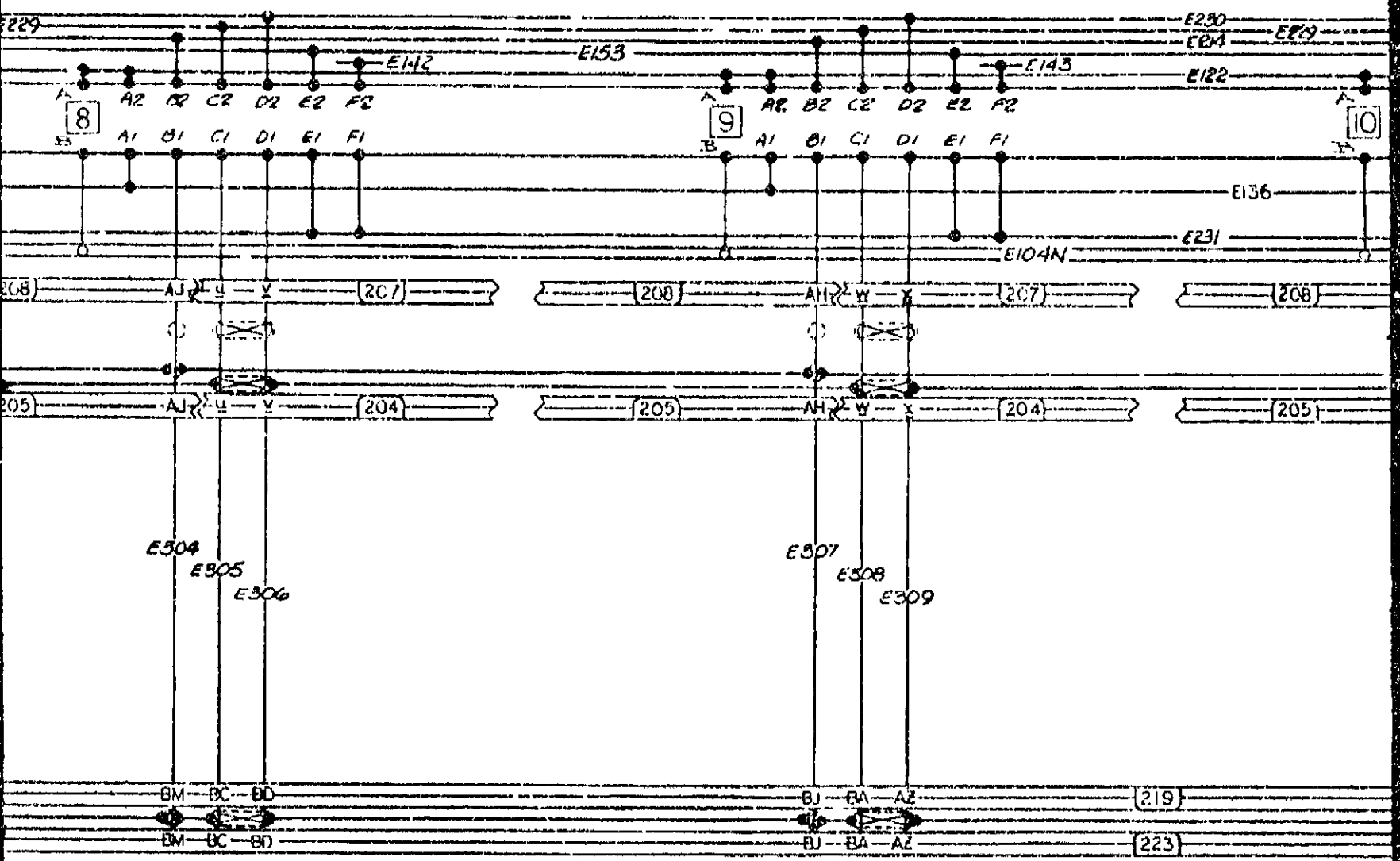


Figure 5-17. Electrical Schematic
Checkout Console (S

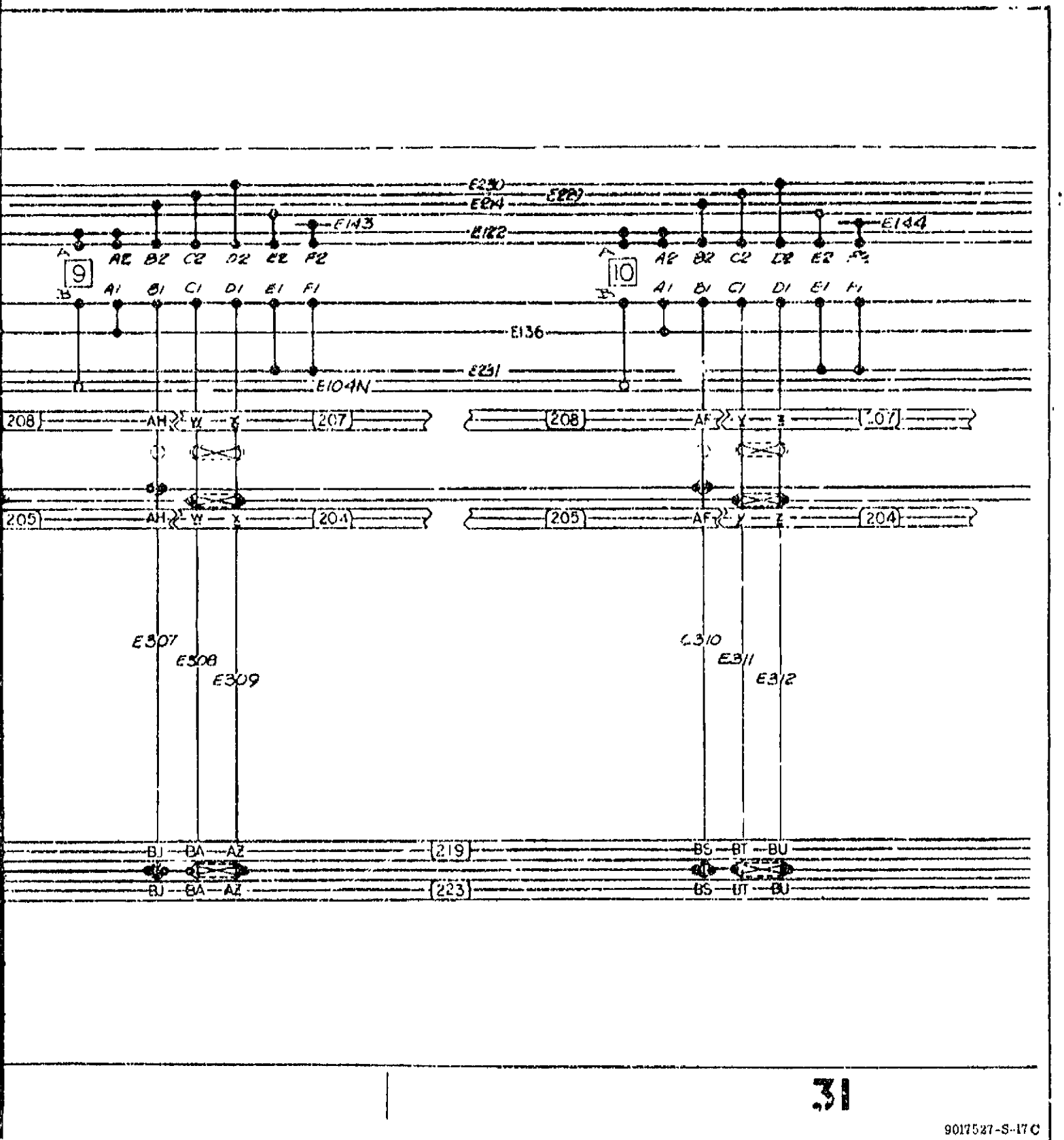
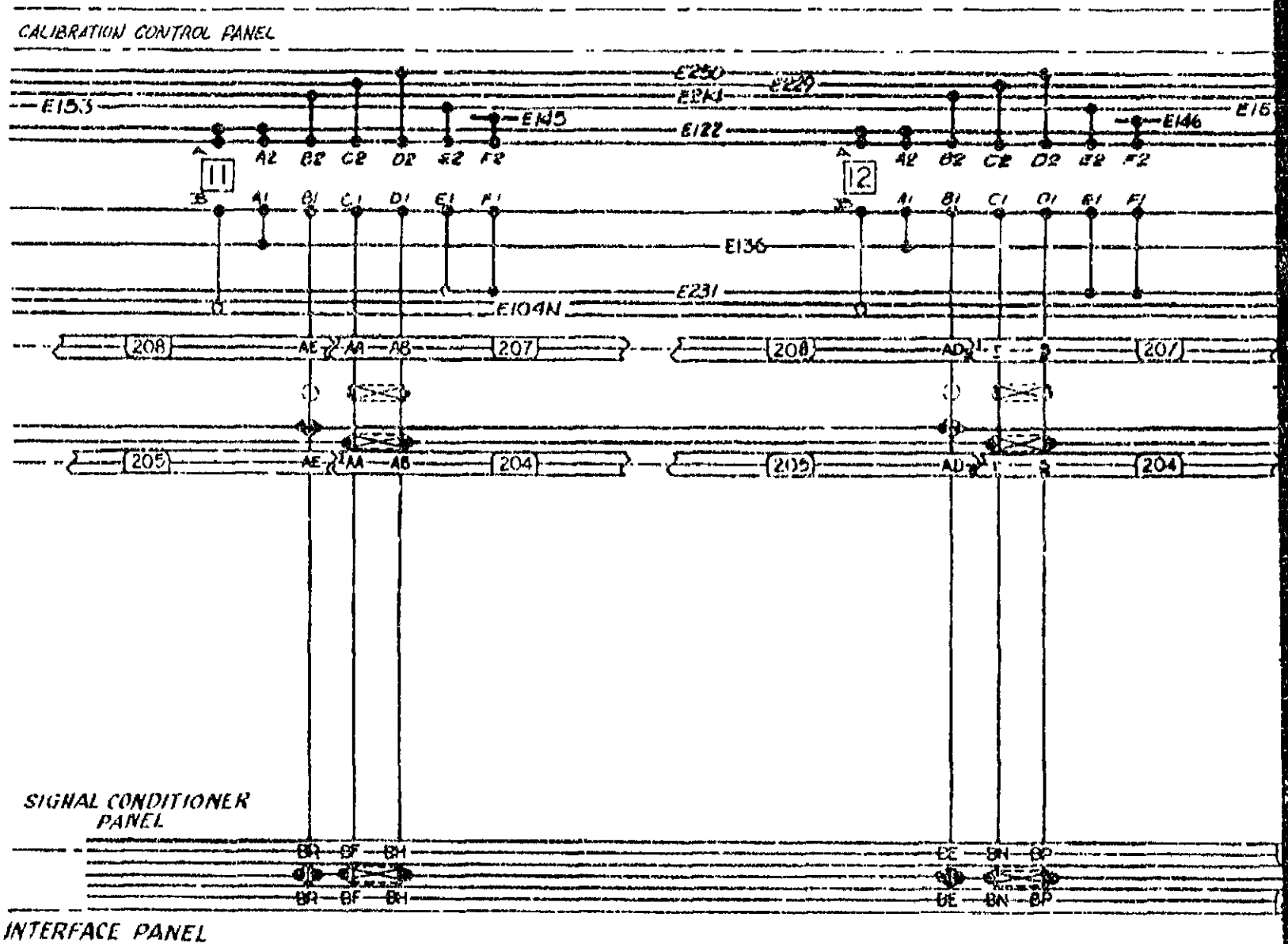
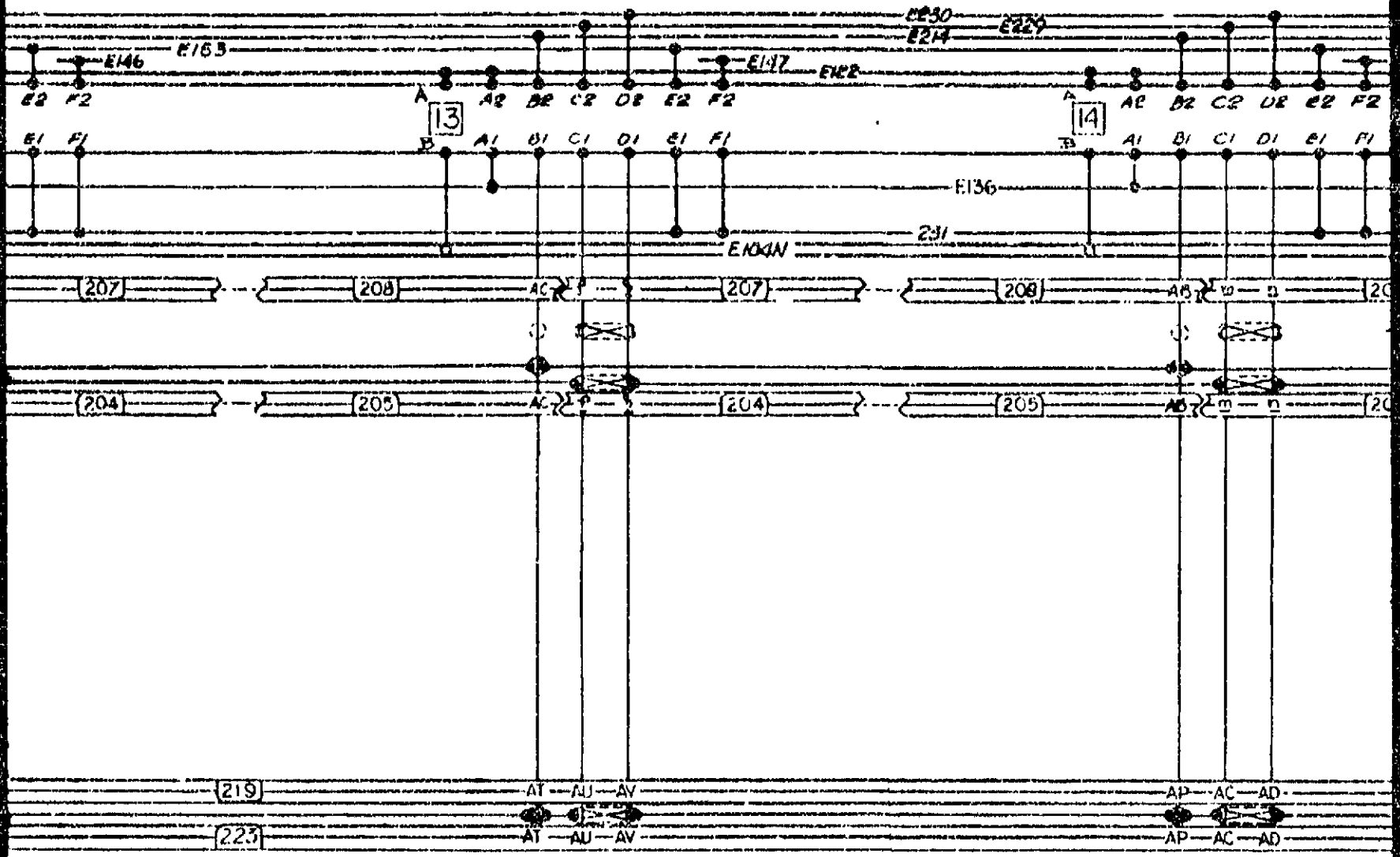
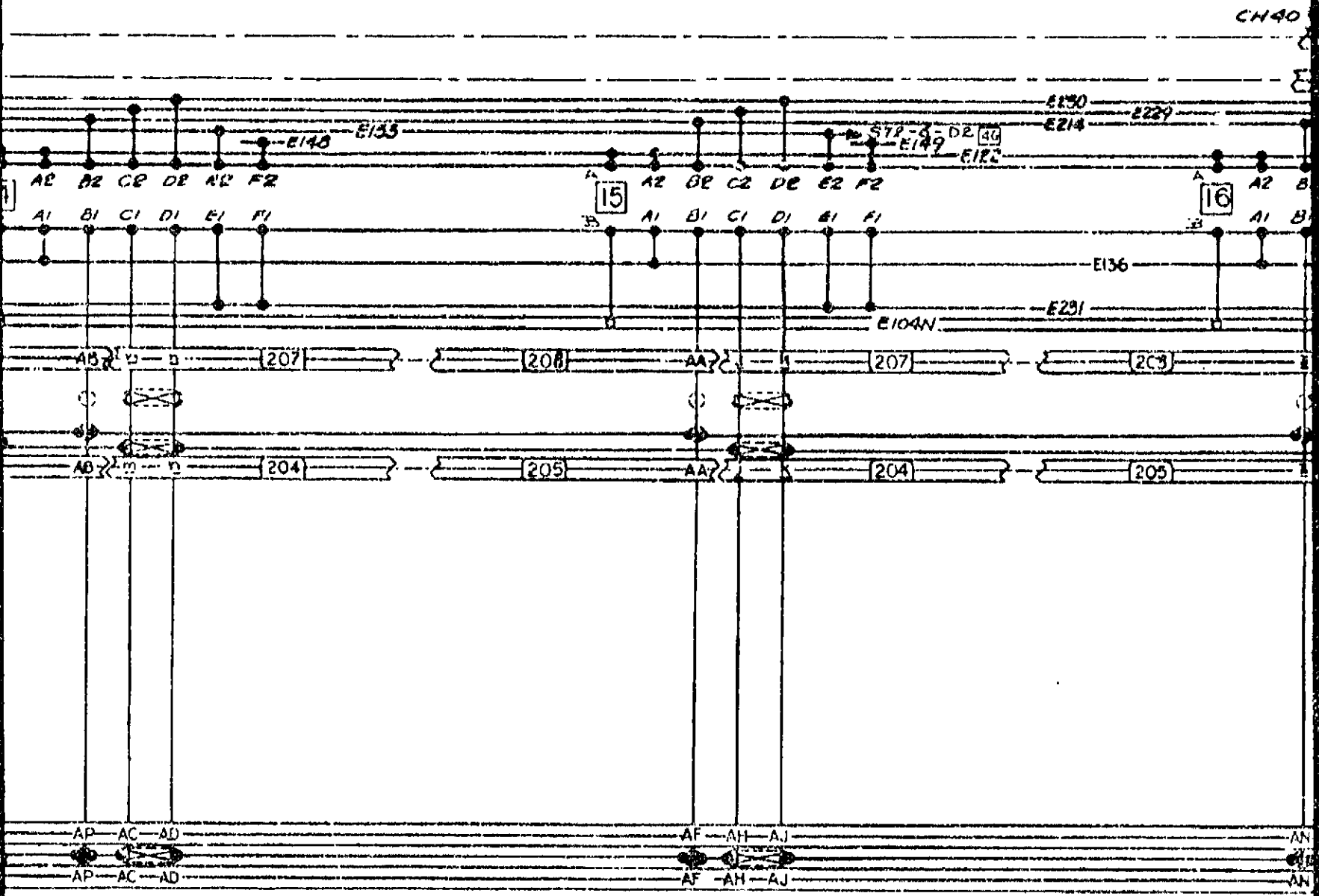


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 9 of 16)


CALIBRATION CONTROL PANEL
E153
E135
E250
E243
E229
E122
E146
E16
11
12
A2 B2 C2 D2 E2 F2
A1 B1 C1 D1 E1 F1
E136
E231
E104N
208
207
205
204
AE AA AB
AD
SIGNAL CONDITIONER PANEL
BG BF BH
BE BN BP
INTERFACE PANEL


E146
E163
E147
E162
E230
E214
E229
E2 F2
A2 B2 C2 D2 E2 F2
13
14
E1 F1
A1 B1 C1 D1 E1 F1
E136
231
E10KIN
207
208
204
205
AC
AB
219
223
AT AU AV
AP AC AD



34

Figure 5-17. Electrical Schematic for Fli
Checkout Console (Sheet 10

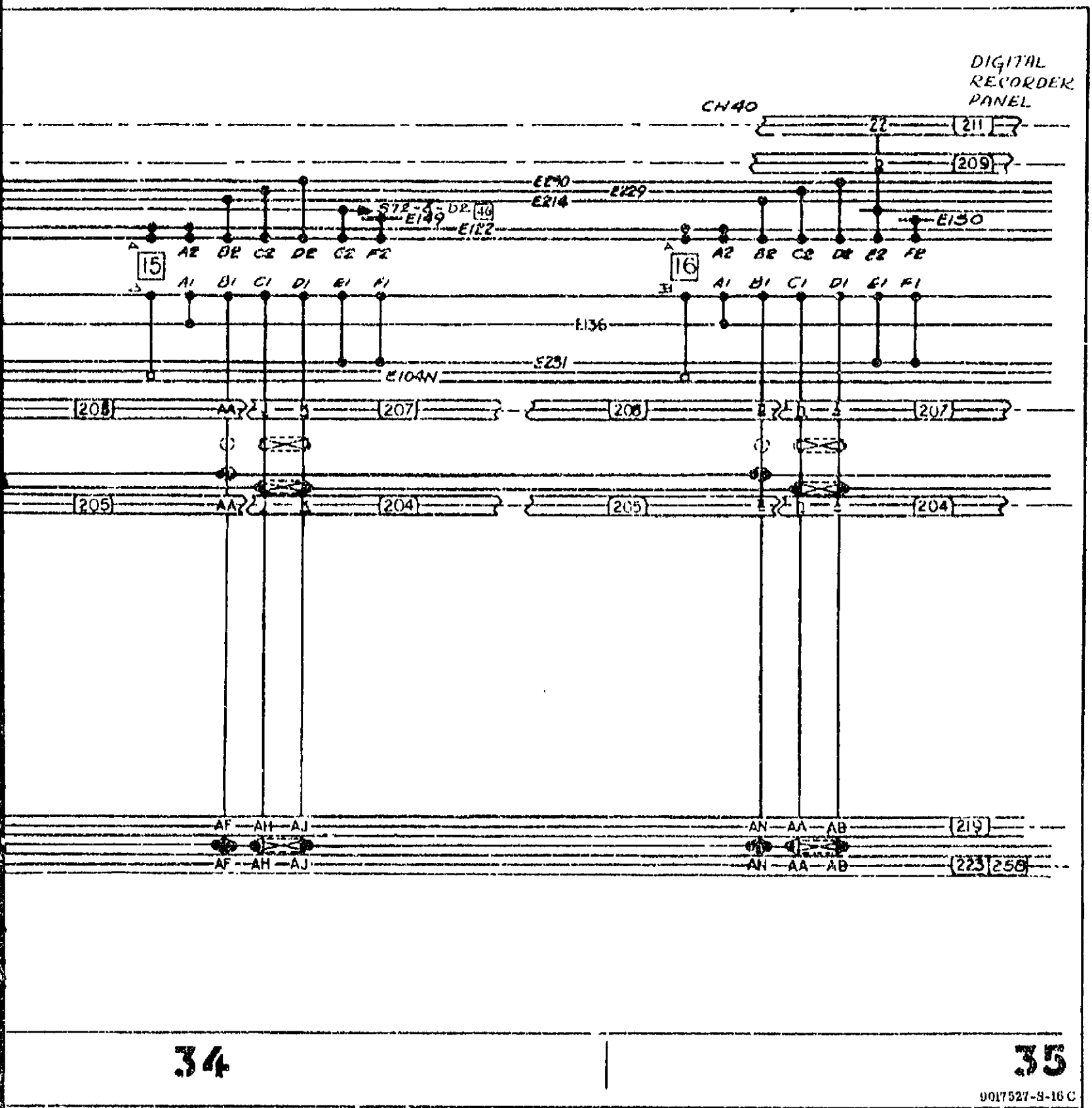
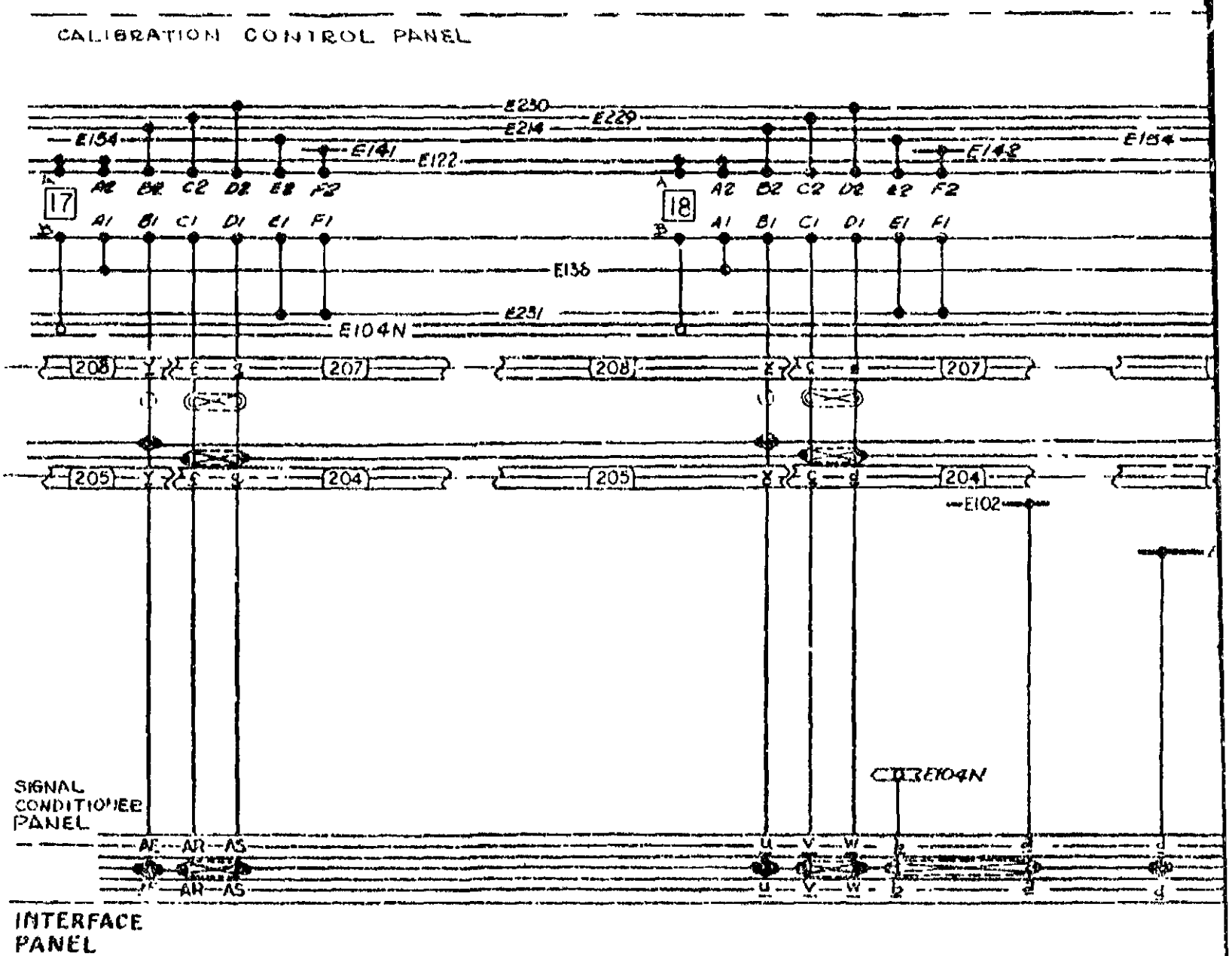
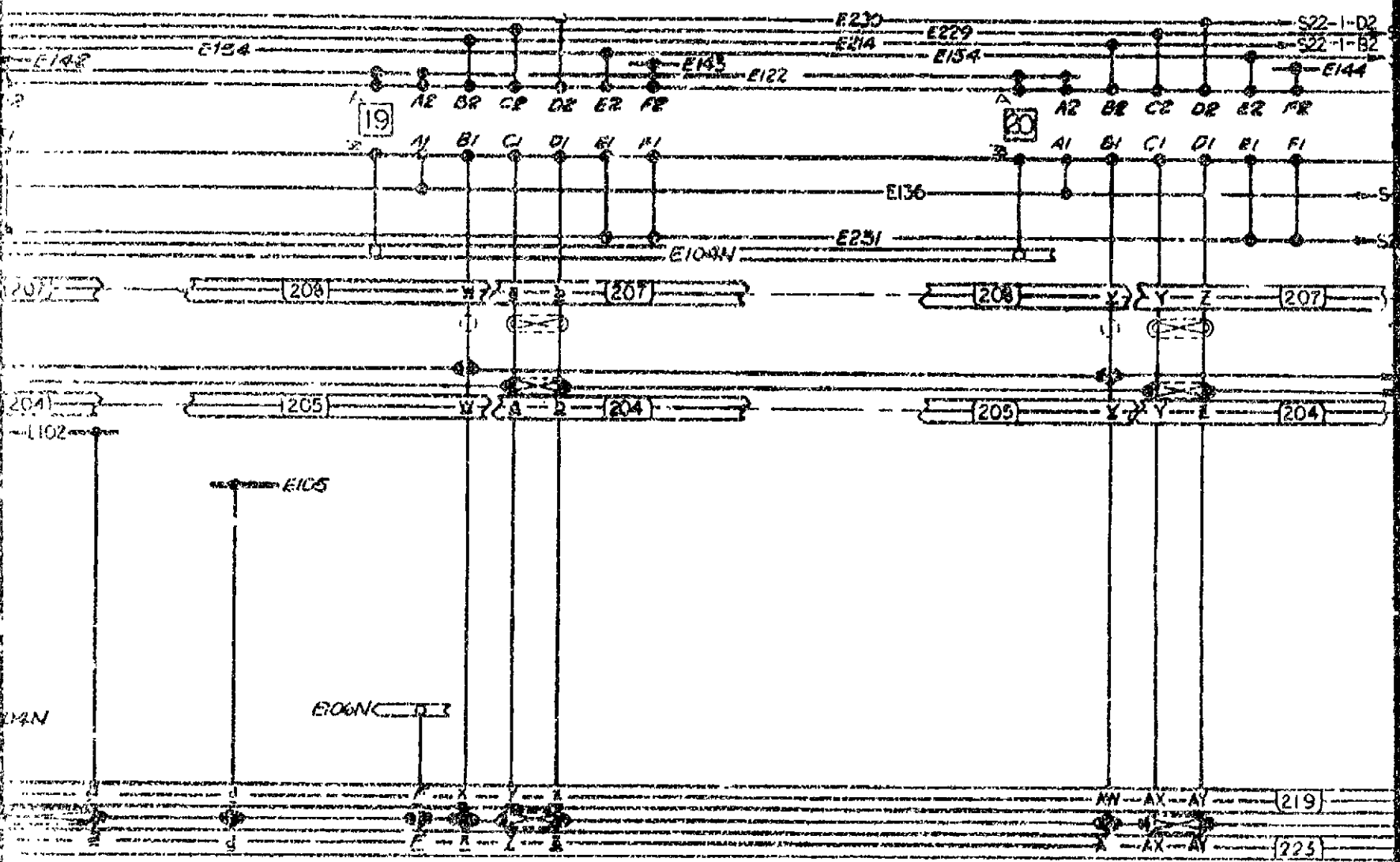


Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 10 of 16)


CALIBRATION CONTROL PANEL
E230
E229
E214
E154
E141
E122
E142
E154
17
18
A2 B2 C2 D2 E2 F2
A1 B1 C1 D1 E1 F1
E136
E231
E104N
208
207
205
204
E102
C2 E104N
SIGNAL CONDITIONER PANEL
AR AS
U V W
INTERFACE PANEL


E230
E229
E214
E154
E144
E145
E122
E136
E231
E104N
E105
E106N
19
20
208
207
205
204
219
225

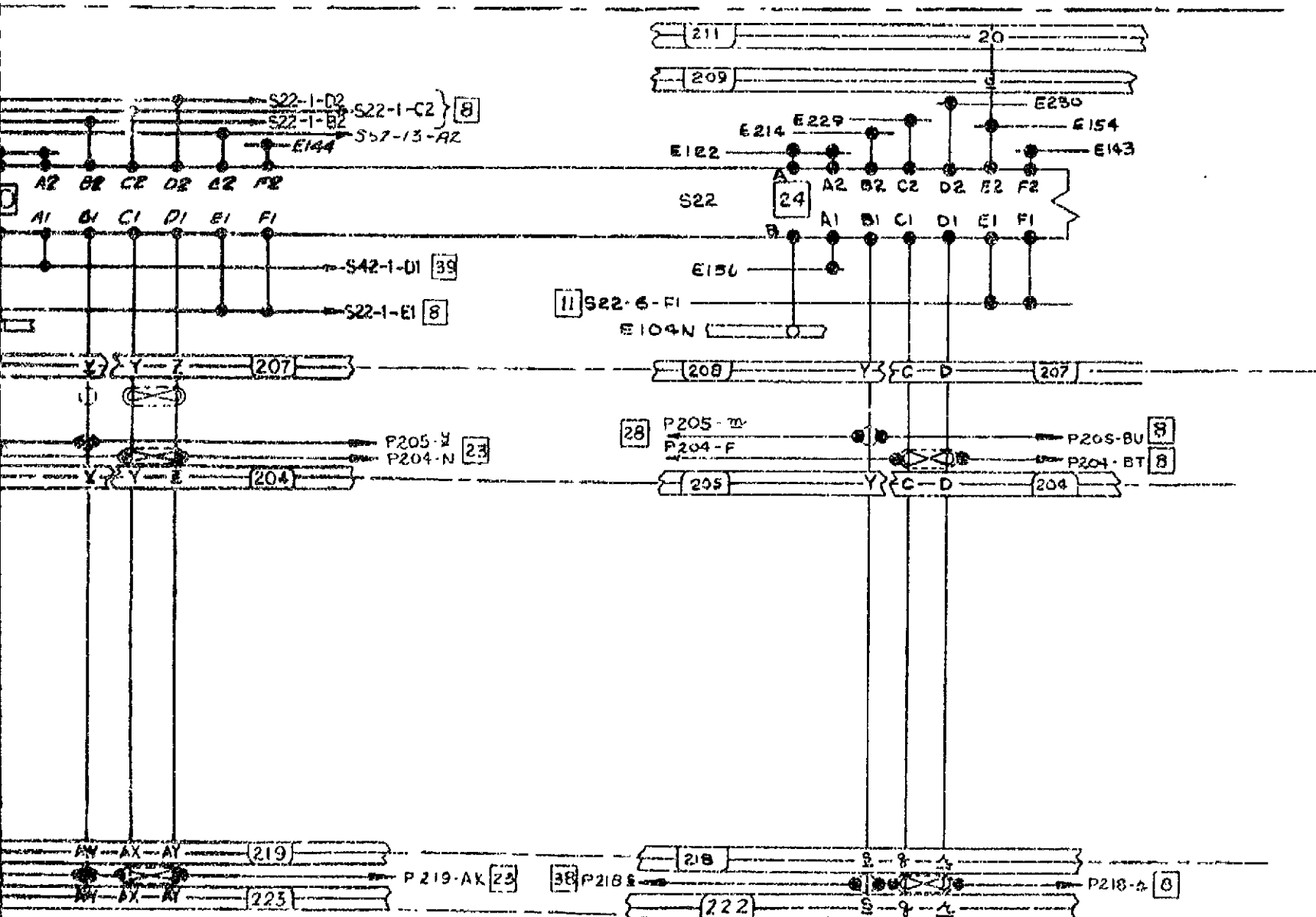
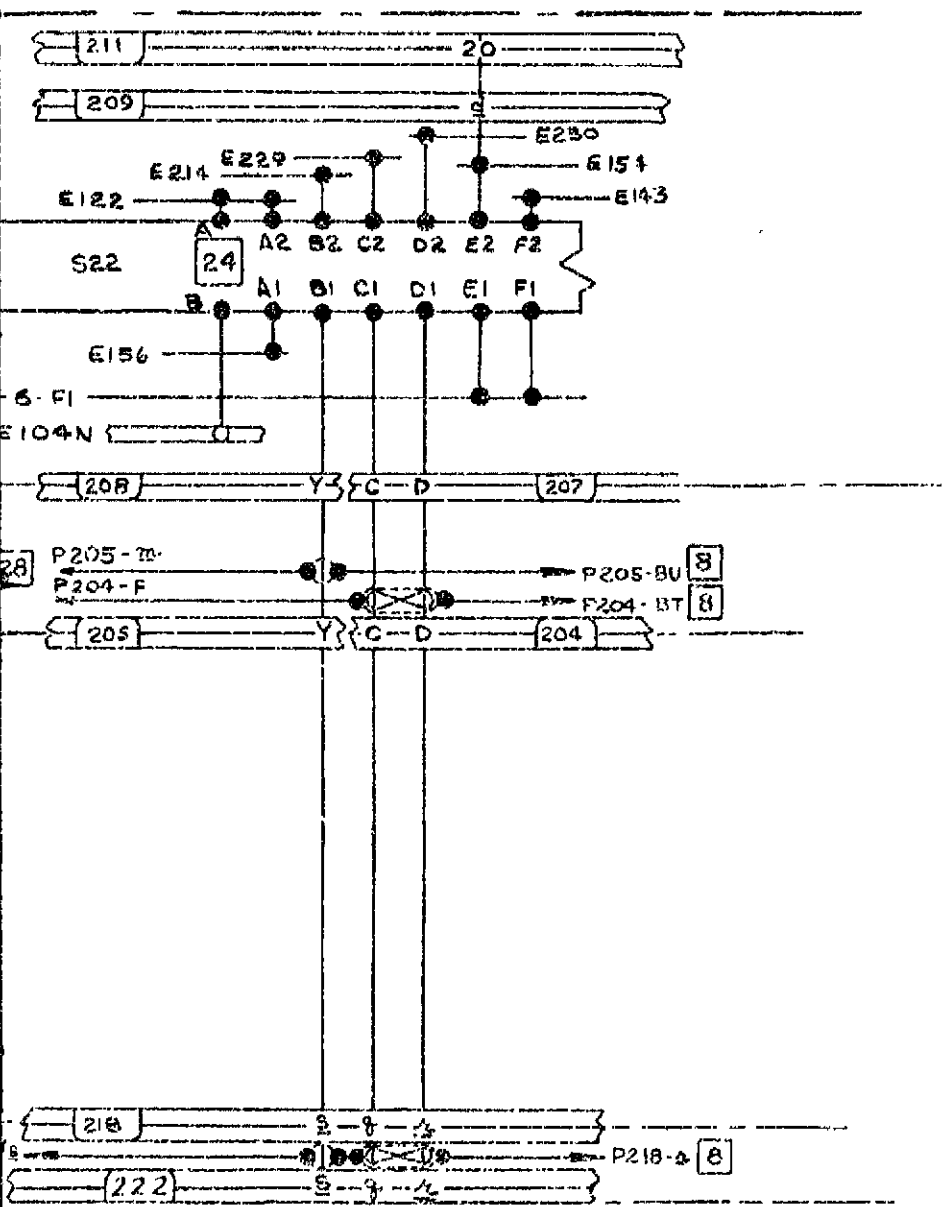


Figure 5-17. Electrical Schem
Checkout Consol



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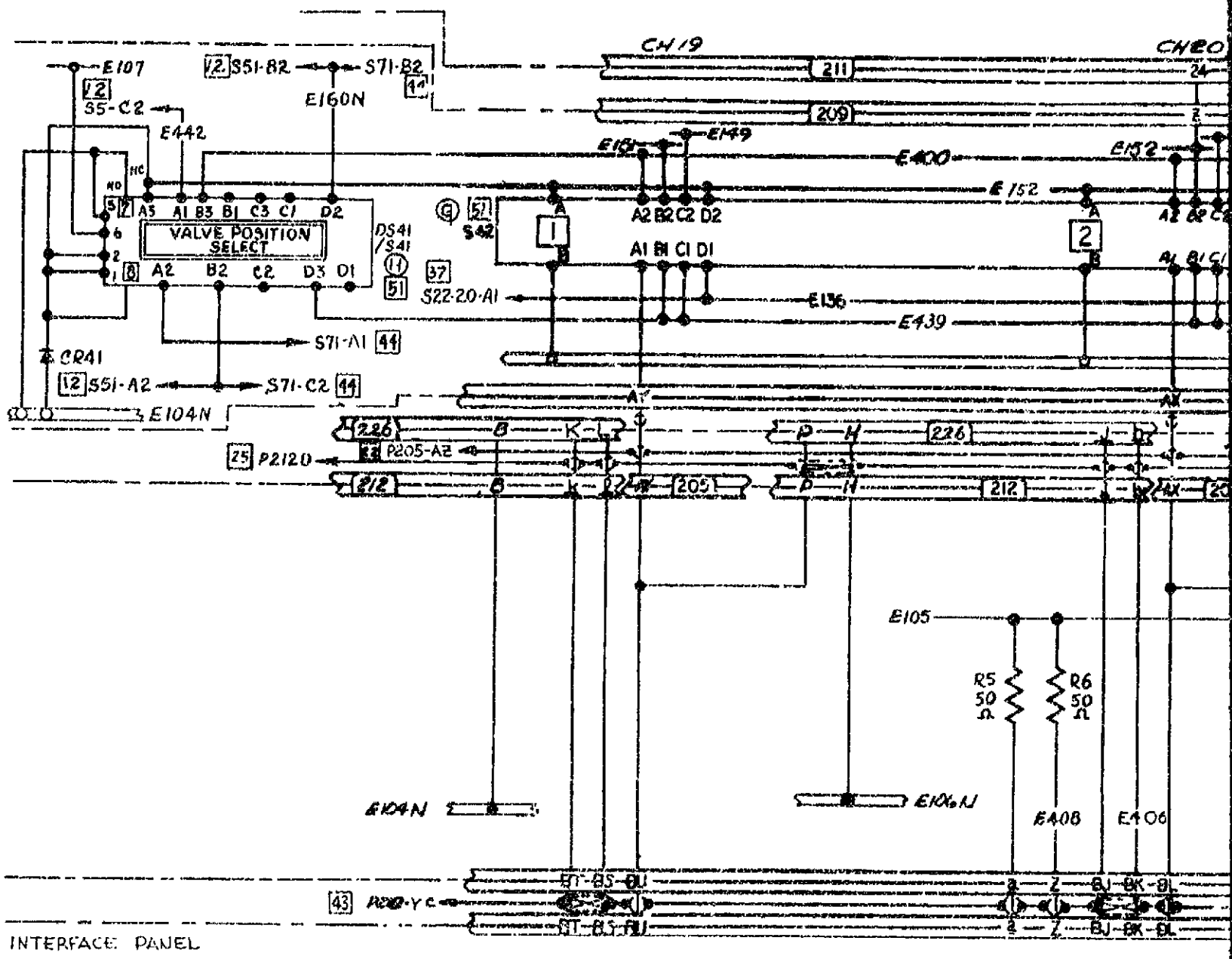
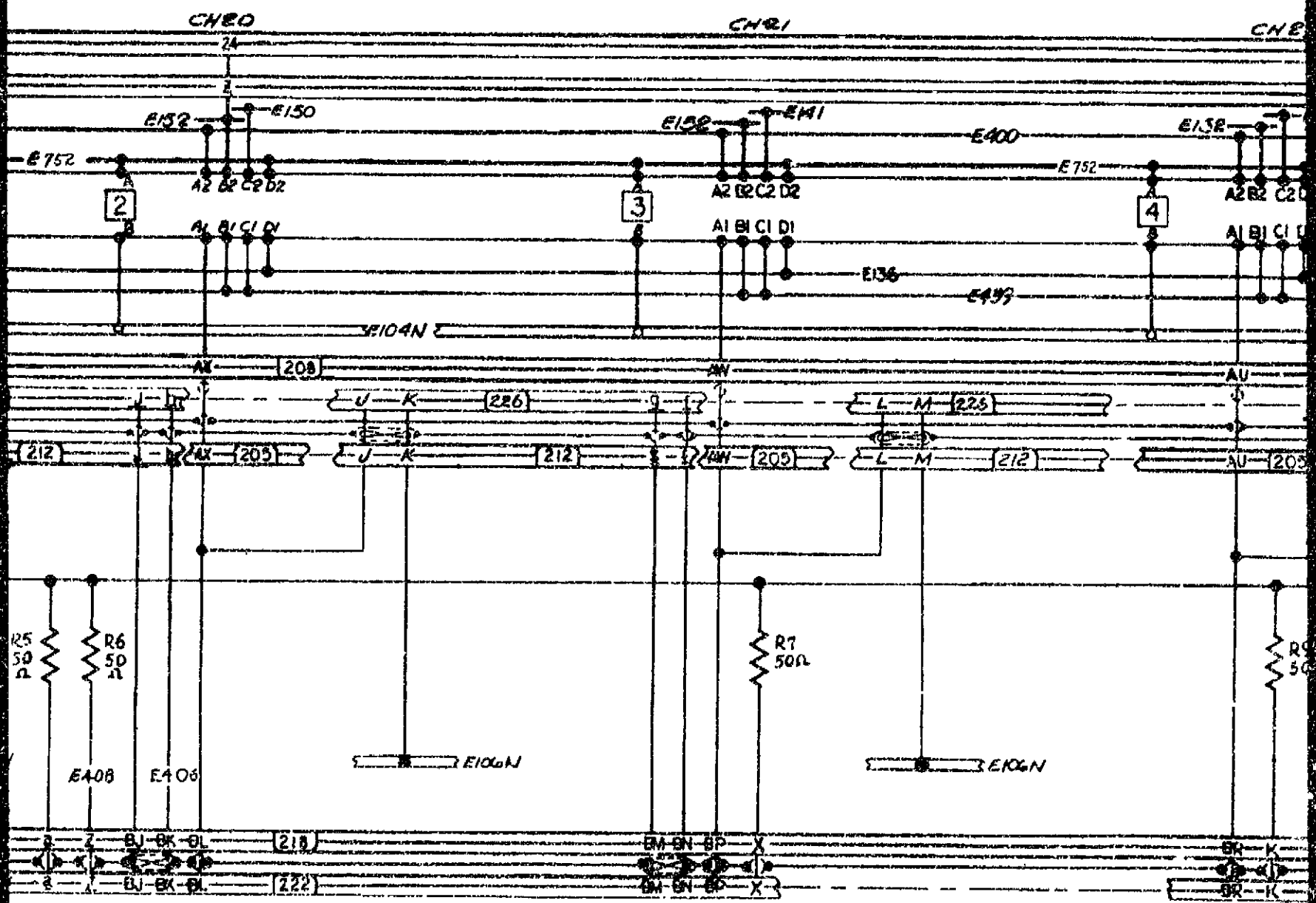
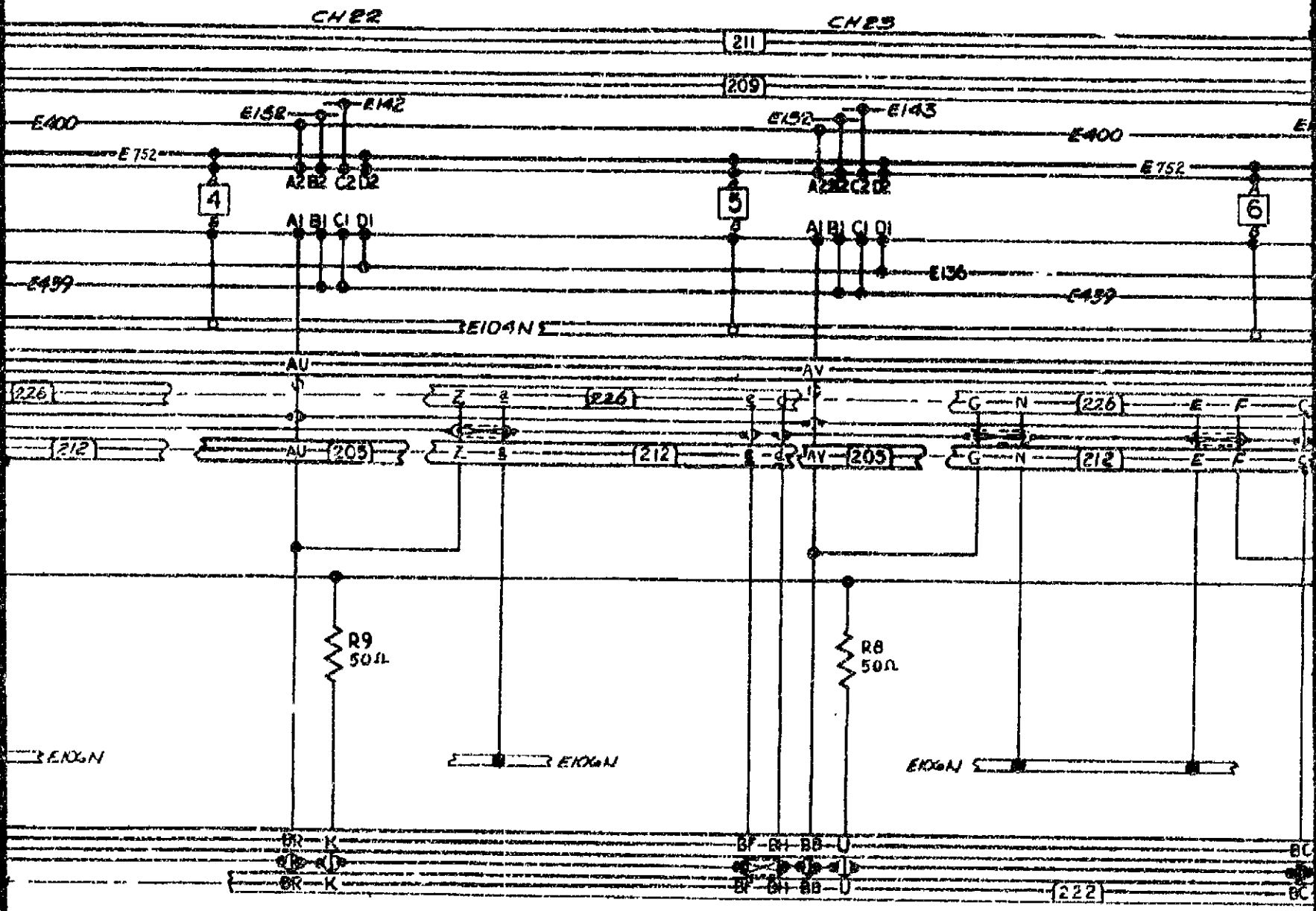
9017527-8-15D

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 11 of 16)

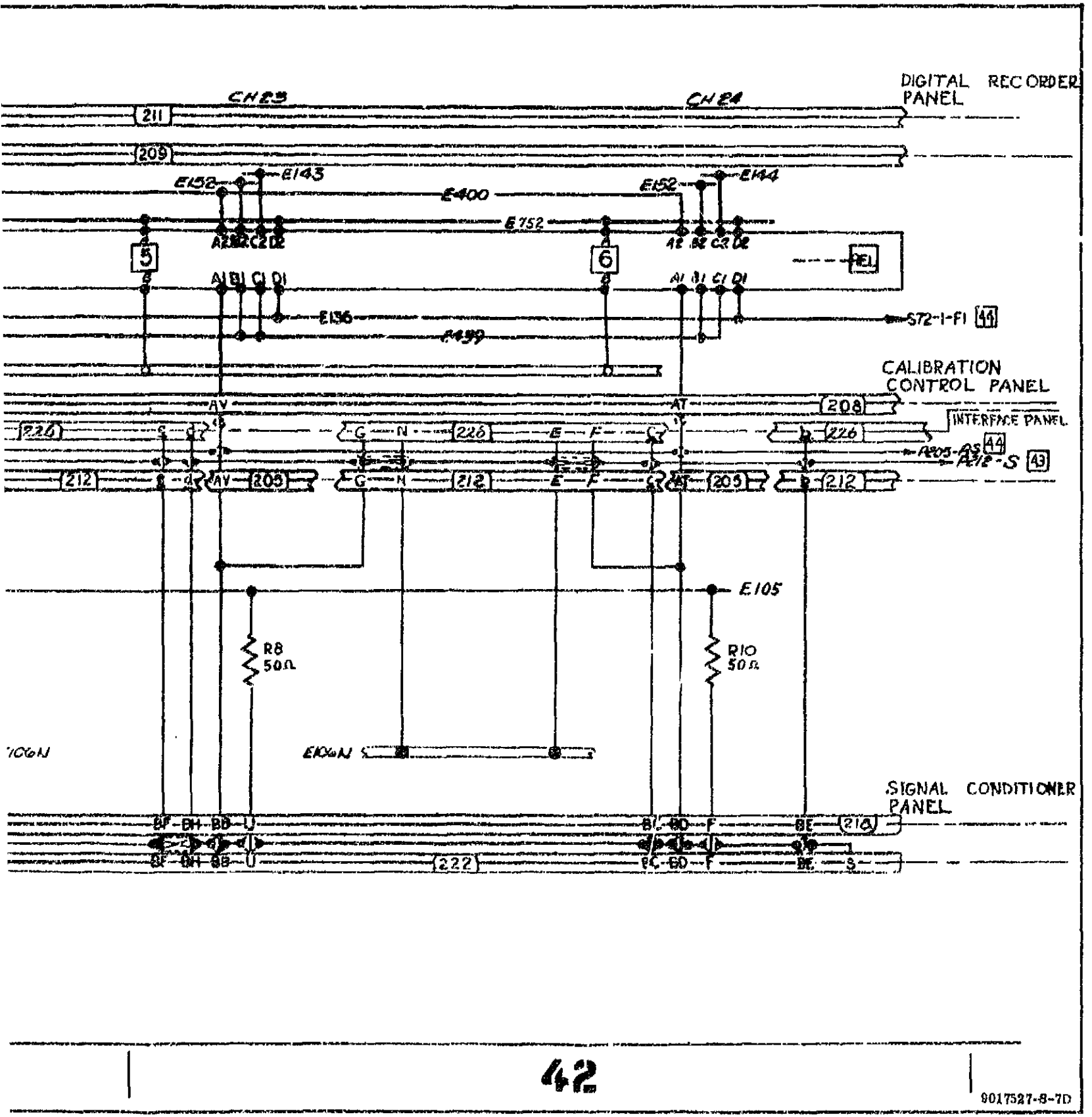

CH19
CH20
E107
V2 S51-B2
S71-B2
E160N
V2 S5-C2
E442
E49
E400
E152
E132
VALVE POSITION SELECT
DS41 /S41
S42
A5 A1 B3 B1 C3 C1 D2
A8 A2 B2 C2 D3 D1
A2 B2 C2 D2
A1 B1 C1 D1
S22-20-A1
E136
E439
S71-A1
CR41
S51-A2
S71-C2
E104N
P205-A2
P212-B
P205
P212
E105
R5 50 Ω
R6 50 Ω
E104N
E106N
E408
E406
S71-B5-BJ
S71-B5-BJ
INTERFACE PANEL


CHEO
CHRI
24
E152
E150
E752
E400
E136
E493
E104N
208
226
225
212
205
R5 50Ω
R6 50Ω
R7 50Ω
E406
E106N
218
222



41 | 42

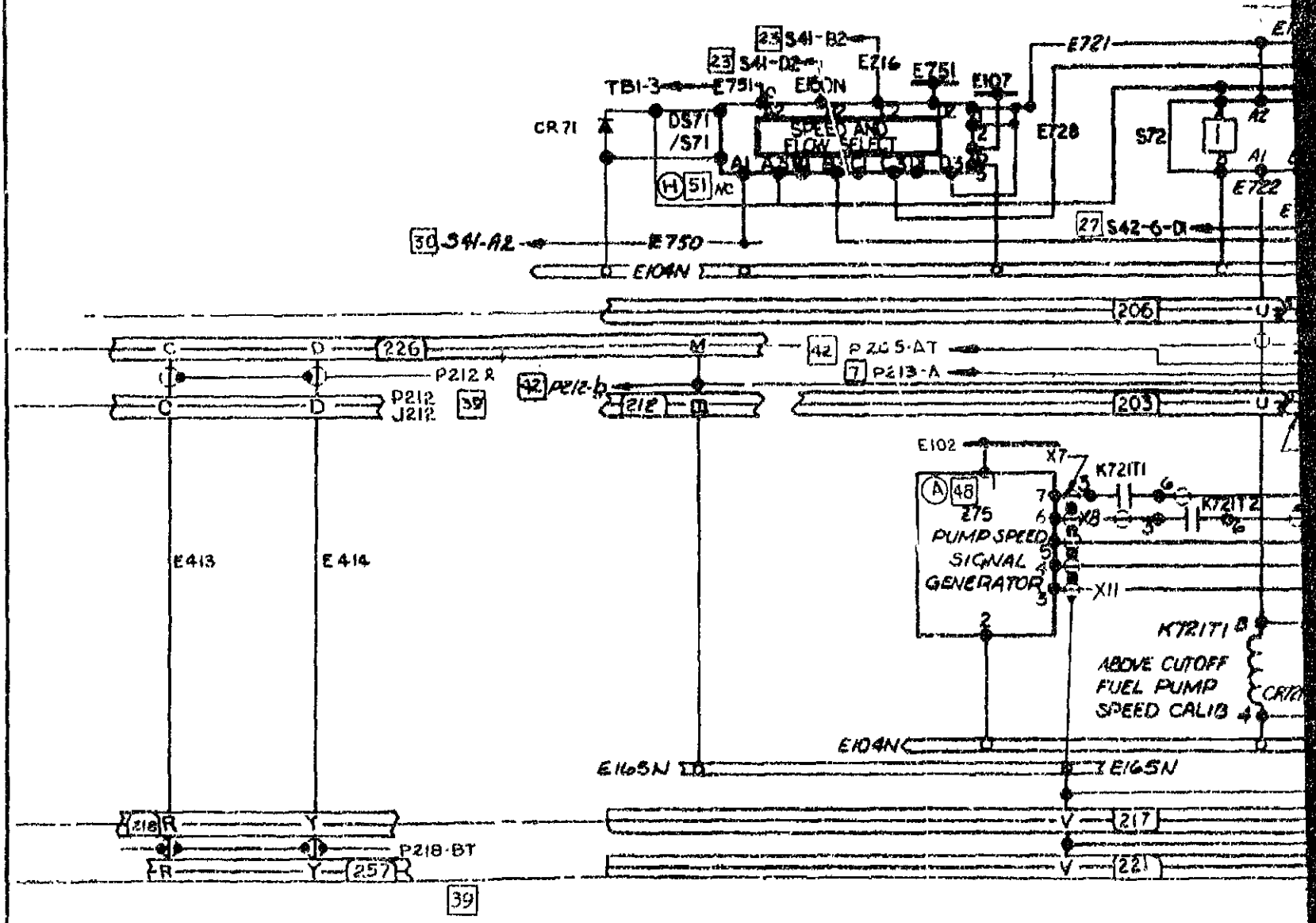
Figure 5-17. Electrical Schema
Checkout Console

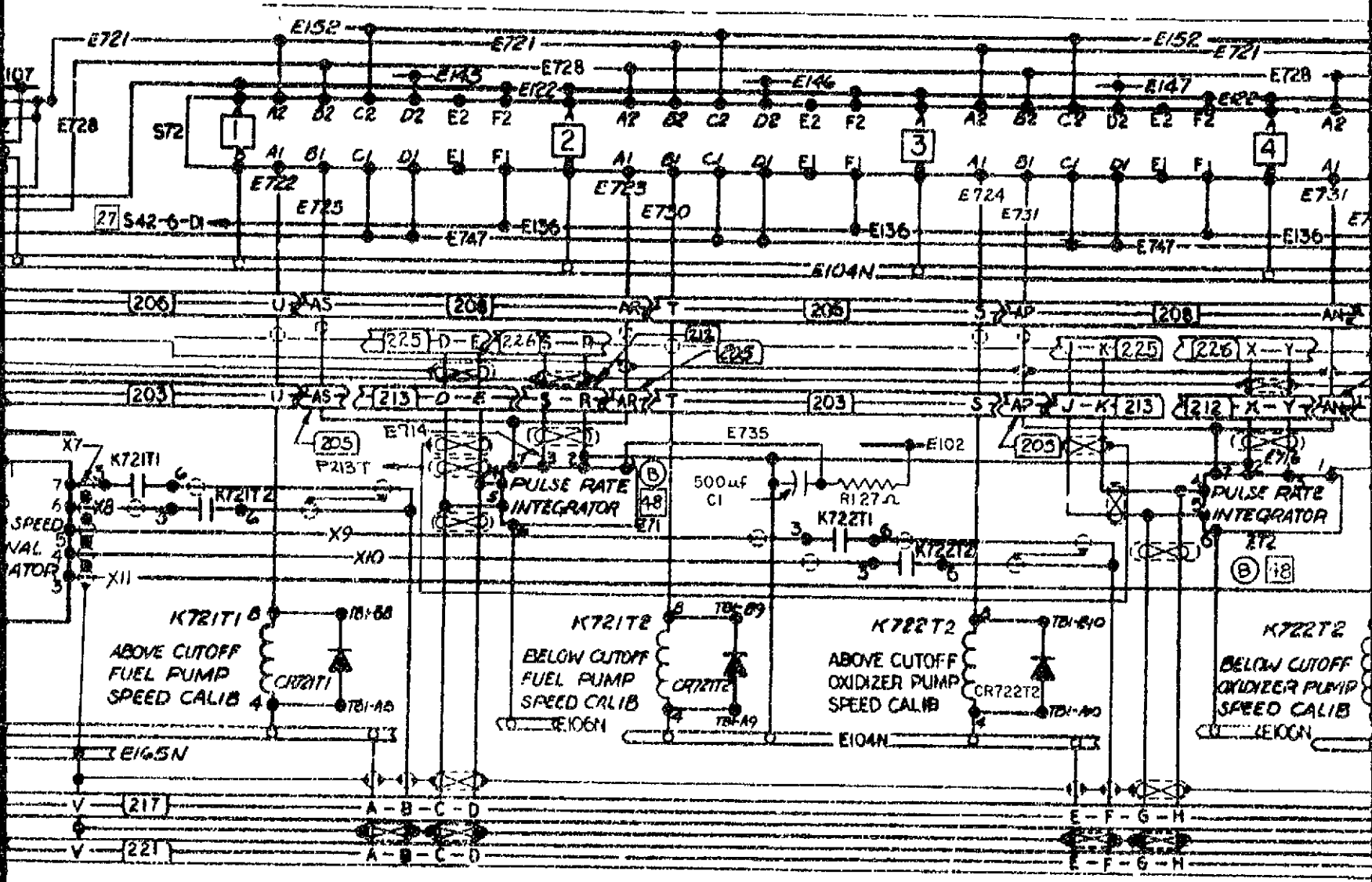


42

9017527-8-7D

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 12 of 16)


23 S41-B2
23 S41-D2
TB1-3
E751
E216
E751
E107
E721
CR71
DS71
/S71
SPEED AND
FLOW SELECT
E728
S72
E722
H 51 NC
30 S41-A2
E750
E104N
27 S42-G-D1
206
226
P212 R
P212
J212
59
42 P205-AT
7 P213-A
32 P212-b
212
203
E102
X7
K721T1
A 48
Z75
PUMP SPEED
SIGNAL
GENERATOR
X8
K721T2
X11
K721T1
ABOVE CUTOFF
FUEL PUMP
SPEED CALIB
E104N
E165N
E165N
E413
E414
216
P218-BT
257
217
221
39


K721T1
ABOVE CUTOFF
FUEL PUMP
SPEED CALIB
K721T2
BELOW CUTOFF
FUEL PUMP
SPEED CALIB
K722T1
ABOVE CUTOFF
OXIDIZER PUMP
SPEED CALIB
K722T2
BELOW CUTOFF
OXIDIZER PUMP
SPEED CALIB
PULSE RATE
INTEGRATOR
500 µf
C1
R127Ω
E104N
E106N
E165N
E735
E102
E714
P213T
ST2
S42-6-D1

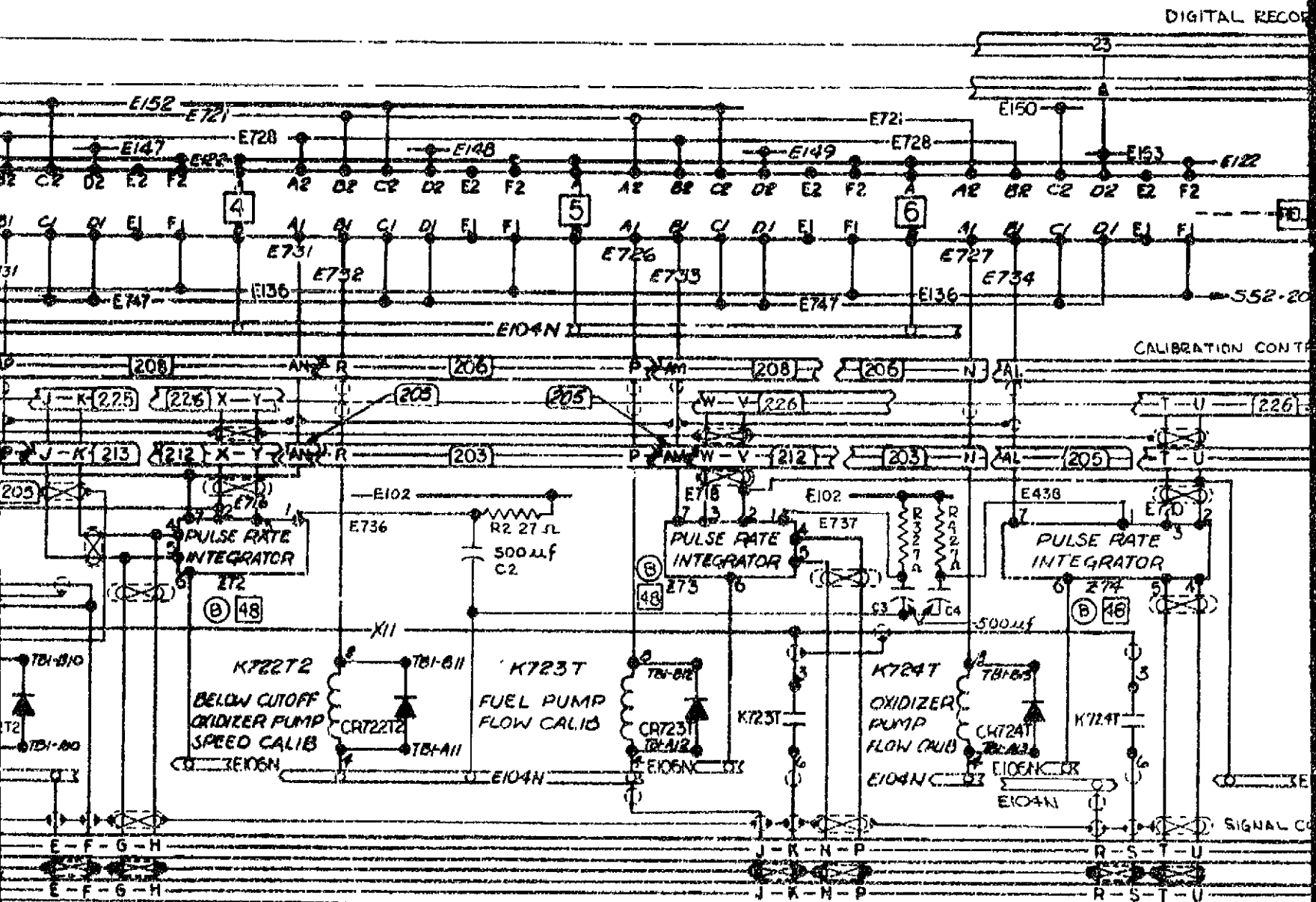


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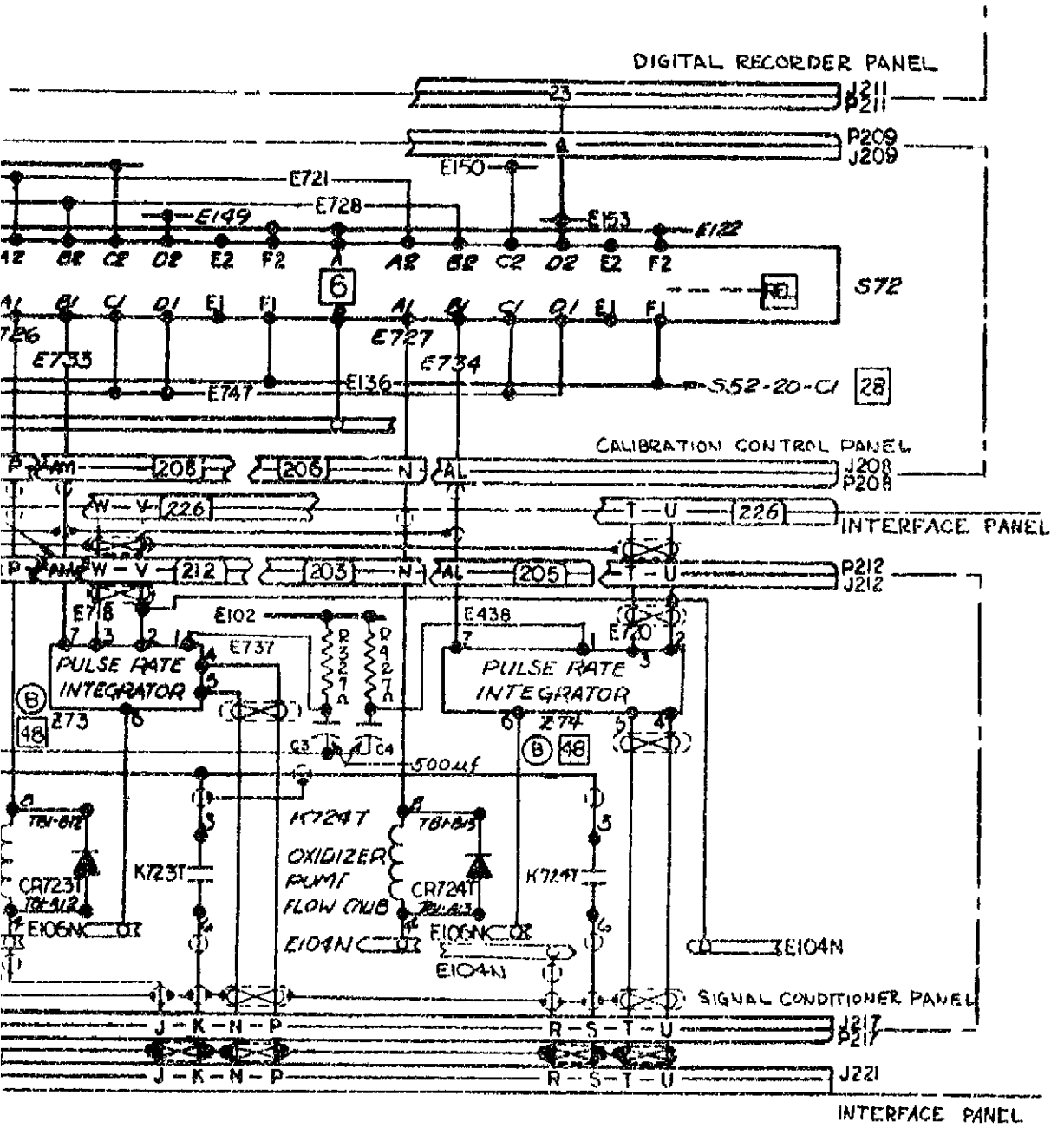
Figure 5-17. Electrical Schem
Checkout Consol



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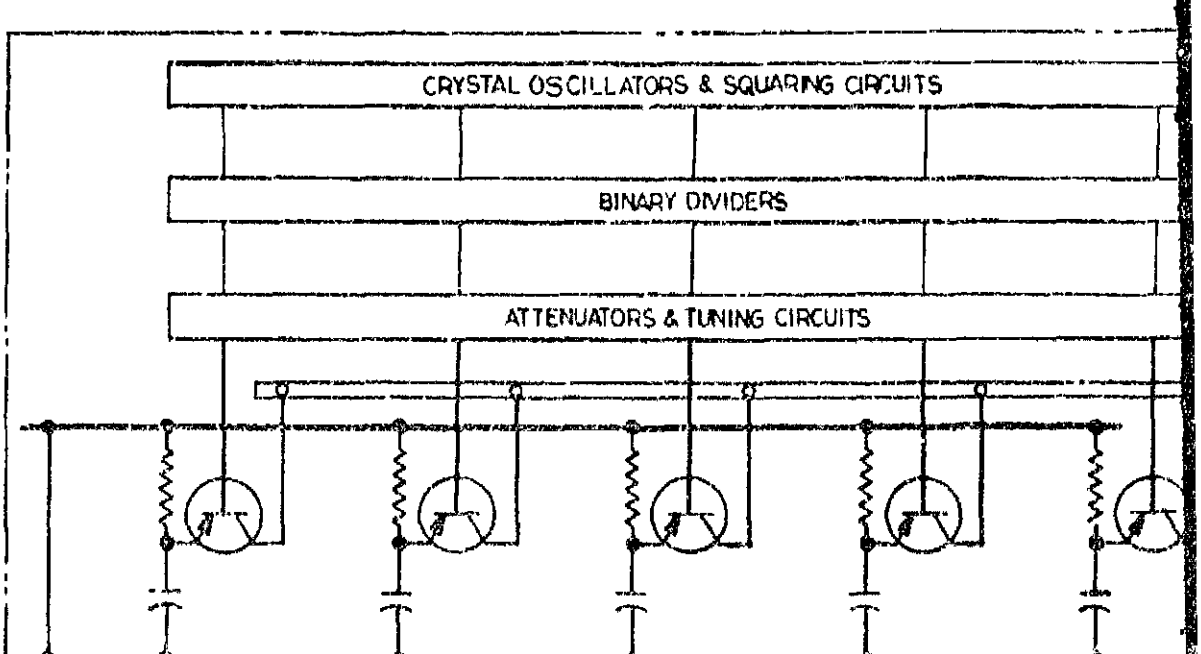
9017527-8-6D

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 13 of 16)

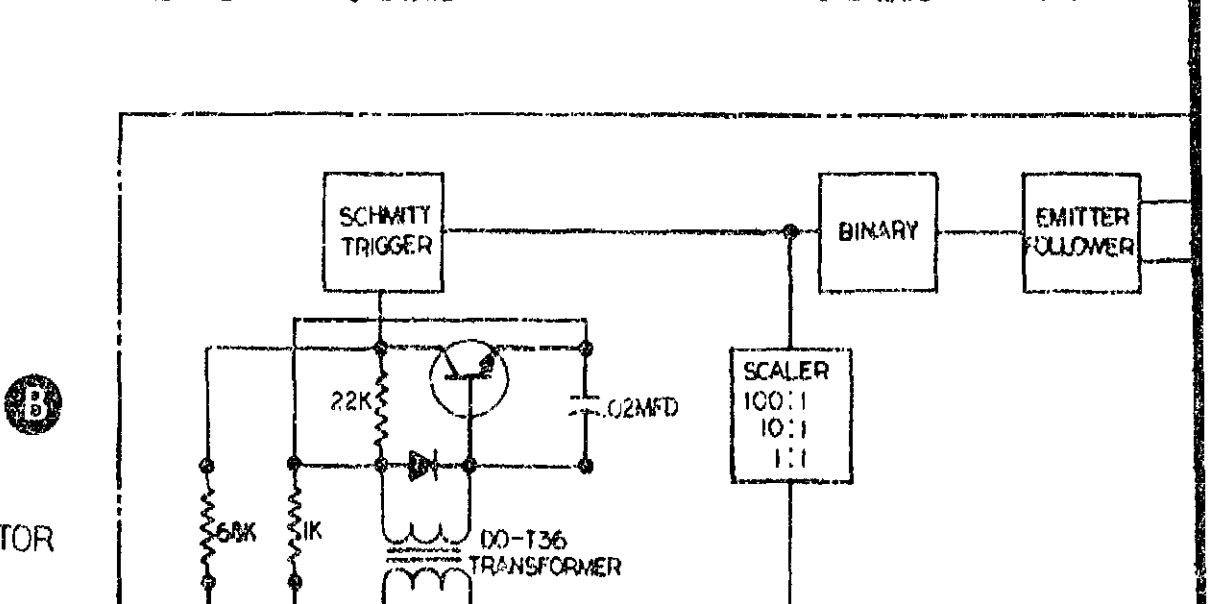
SIGNAL GENERATOR

A



PULSE RATE INTEGRATOR

B



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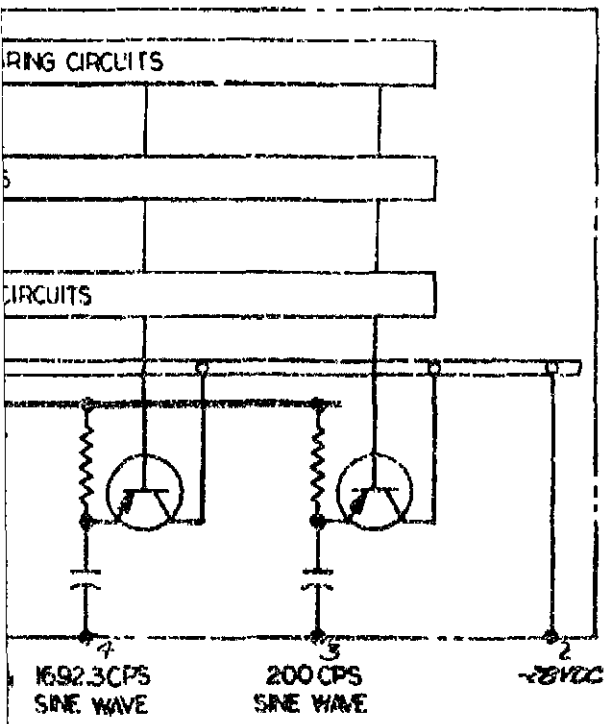
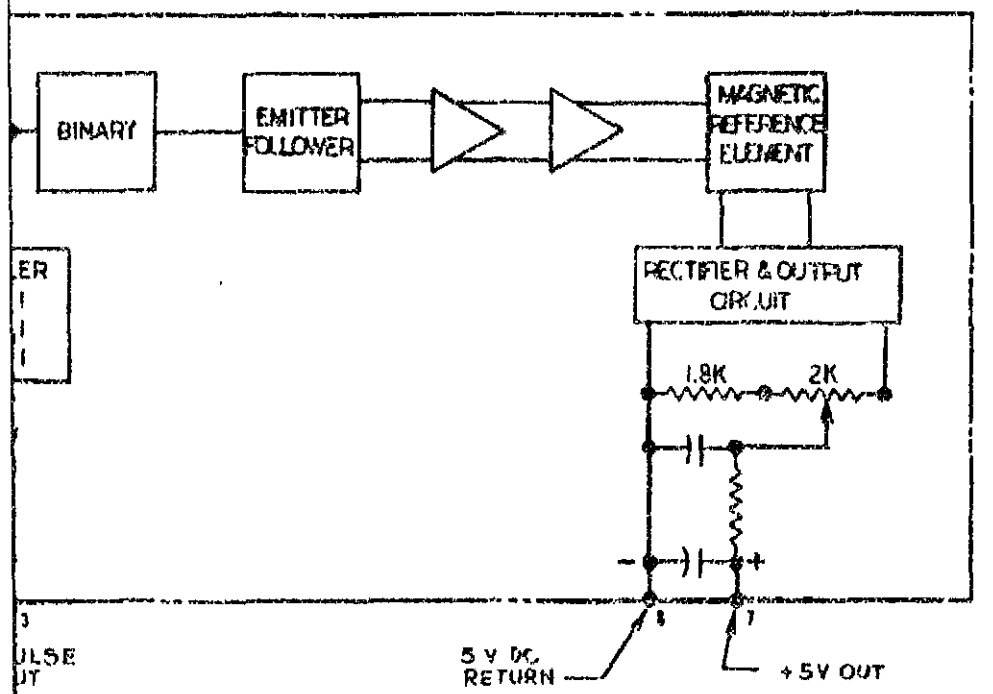


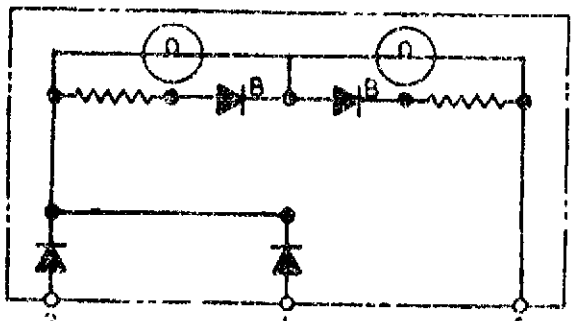


9017527-8-5C

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 14 of 16)

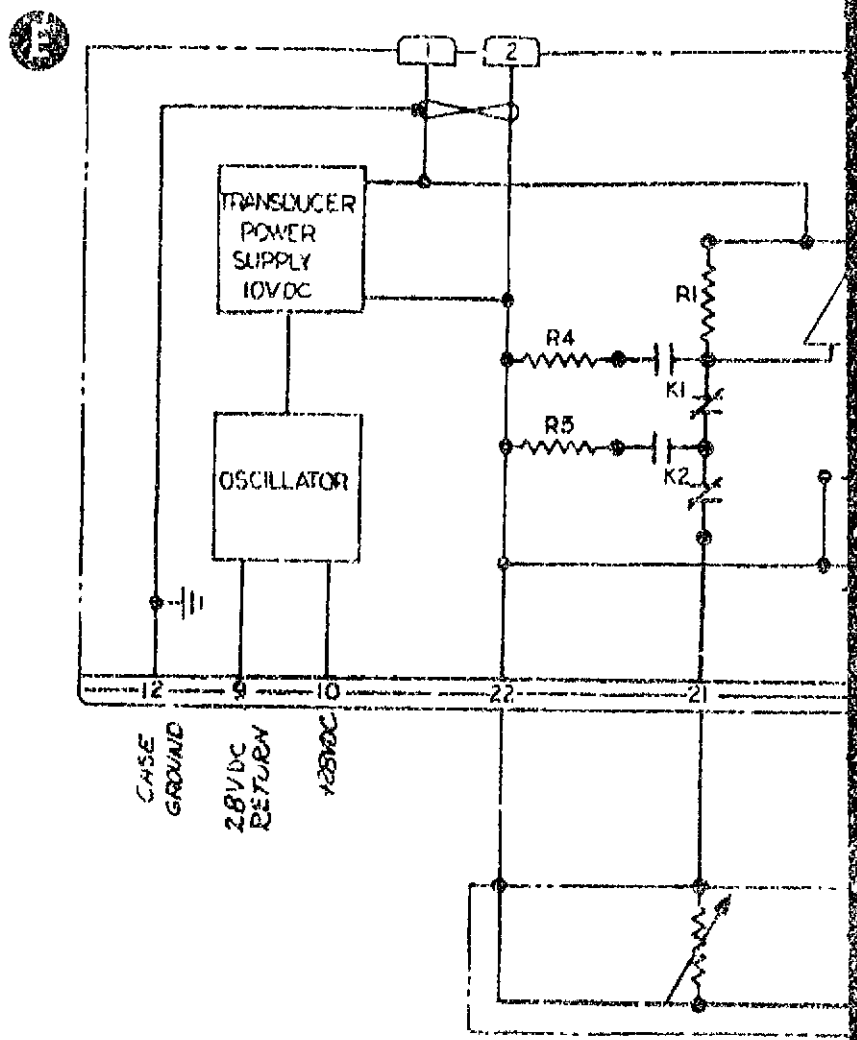
TEMPERATURE S

CONTROL LIGHT ASSEMBLY

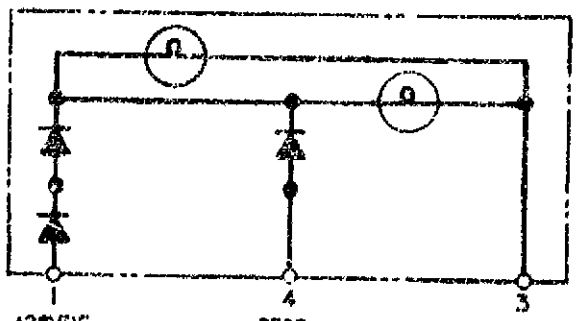


RD450-2002-0001

C



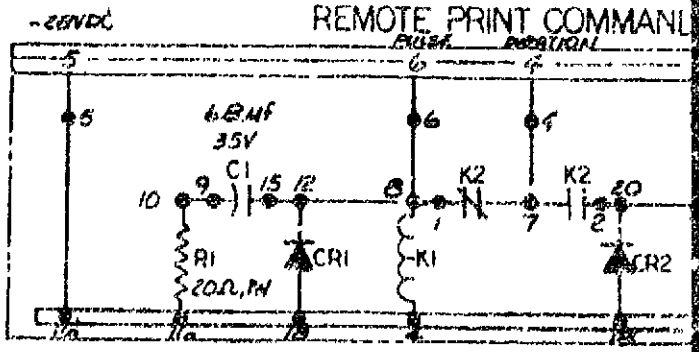
CONTROL LIGHT ASSEMBLY



RD450-2001-0001

B

F



Z11

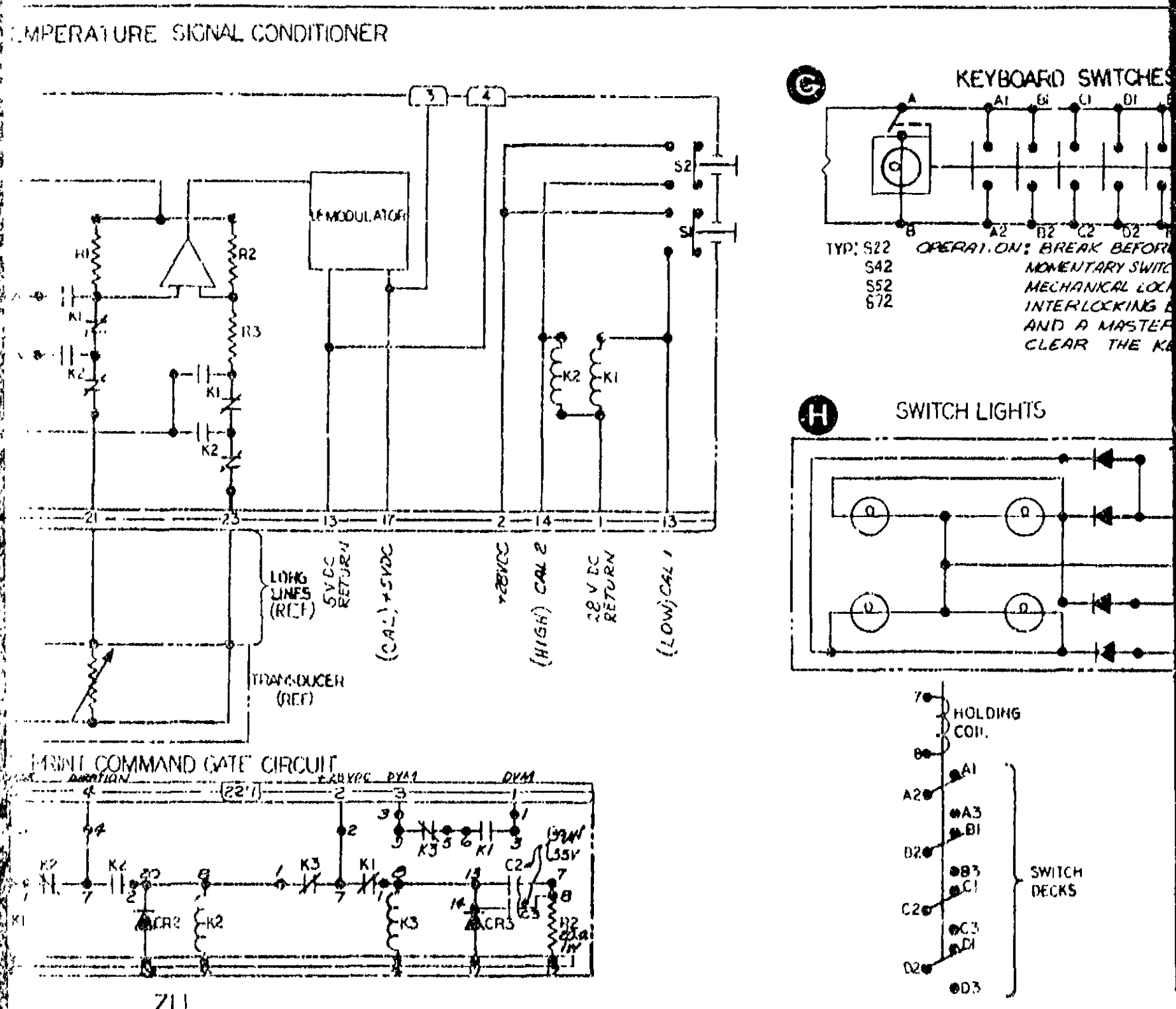
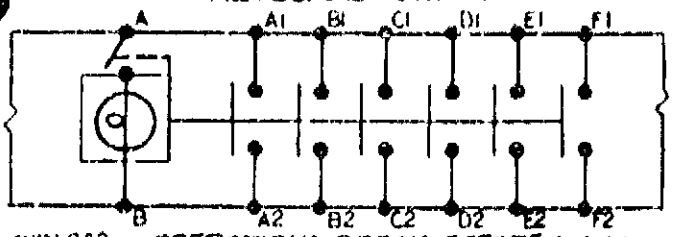


Figure 5-17. Electric
Checko

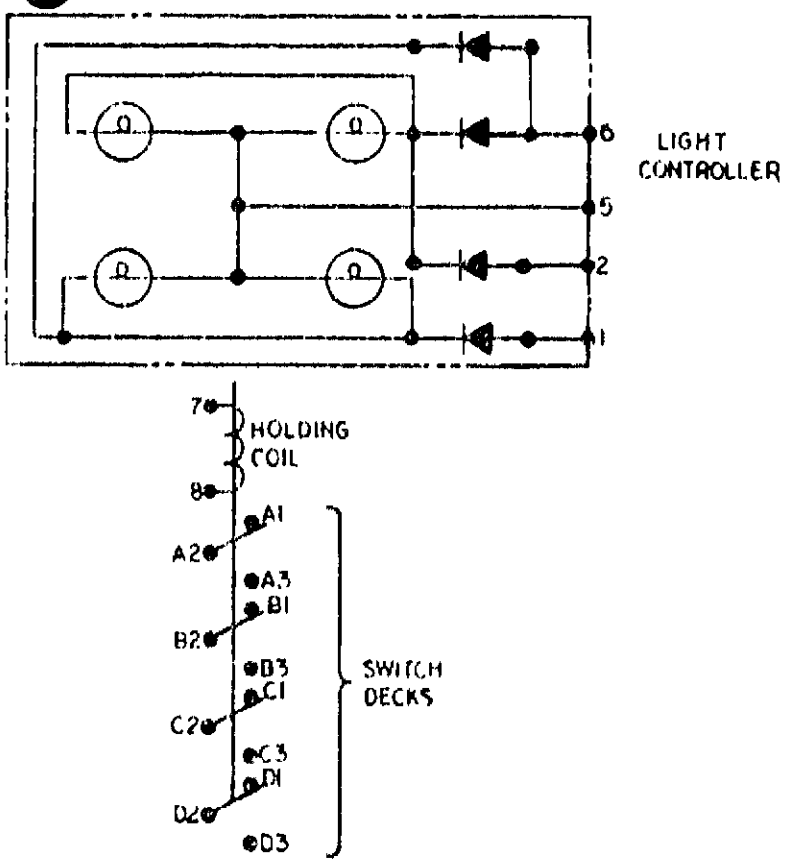
G KEYBOARD SWITCHES



TYP: S22
S42
S52
672

OPERATION: BREAK BEFORE MAKE, MOMENTARY SWITCH ACTION WITH MECHANICAL LOCKING AND INTERLOCKING BETWEEN STATIONS, AND A MASTER RELEASE TO CLEAR THE KEYBOARD

H SWITCH LIGHTS



51

9017527-8-4C

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 15 of 16)

Relay	Zone		
	Coil	Normally Open	Normally Closed
K1	3	2, 3	- - -
K2	3	3	- - -
K3	3	4, 5	- - -
K4	5	6, 6	- - -
K5	6	6	- - -
K6-1	6	6, 6	6
K6-2	6	- - -	- - -
K7	- - -	- - -	6
K721T1	44	44	- - -
K721T2	45	44	- - -
K722T1	45	45	- - -
K722T2	45	45	- - -
K723T	46	46	- - -
K724T	46	46	- - -

Figure 5-17. Electrical Schematic for Flight Instrumentation Checkout Console (Sheet 16 of 16)

5-38. CALIBRATION REQUIREMENTS.

5-39. The calibration control and power supply panel ammeter and voltmeters must be checked to ensure an accuracy of two percent of full scale. The digital voltohmmeter must be checked as outlined in the operating and service manual for NLS, Model M24 (Non-Linear Systems, Inc).

5-40. PREPARING FOR STORAGE.

5-41. Prepare console for storage as follows:

a. Disconnect all external electrical cables from console.

b. Install protective covers on cable connectors and stow cables in console.

c. Install protective caps on console interface panel electrical receptacles.

d. Cover console with greaseproof barrier material (MIL-B-121, Grade A), or equivalent, and seal at bottom edge.

5-42. MAINTENANCE REQUIREMENTS FOR FLIGHT INSTRUMENTATION CHECKOUT CONSOLE COMPONENTS.

5-43. Maintenance of components consists of removing, installing, and cleaning. Function-test the console after component installation. See figures 5-18 through 5-21 for panel and cable wiring diagrams.

5-44. REMOVING AND INSTALLING ELECTRICAL PANELS.

a. Open rear access door or remove panels below CALIBRATION CONTROL panel.

b. Disconnect electrical connectors from panel to be removed.

c. Remove retaining screws from front of console panel and remove panel from console.

NOTE

The signal conditioner panel is track-mounted and slides forward. Removal is accomplished by depressing track stops.

d. Install panel in reverse order of removal. Torque screws to 38-46 inch-pounds.

5-45. REMOVING AND INSTALLING AMPLIFIERS. Removing and installing amplifier circuit cards from the signal conditioner panel require no special instructions, but the circuit cards must be installed in the same location from which they were removed, component-side-up.

5-46. CLEANING ELECTRICAL PANELS. Remove the panel below calibration control panel and gain access to remaining panels through console rear access door. Remove dirt, dust, and foreign matter from panel components and circuitry, using low-pressure (10 psig maximum) gaseous nitrogen (MIL-P-27401) or a vacuum cleaner.

WARNING

Flying particles loosened and propelled by gaseous nitrogen can cause injury to personnel.

5-47. CLEANING BLOWER FILTER. Loosen knurled retaining nuts and remove frame and filter from front of blower. Wash filter with trichloroethylene (MIL-T-27602), then dry by flowing low-pressure (10 psig maximum) gaseous nitrogen (MIL-P-27401) through filter.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapor or prolonged contact with the liquid can cause serious injury or death.

- Flying particles loosened and propelled by gaseous nitrogen can cause injury to personnel.

5-48. CLEANING SIGNAL CONDITIONER AMPLIFIER CONTACTS. Amplifiers must be removed every 90 days and the amplifier ribbon contacts checked for corrosion. Clean corroded contacts as follows:

a. Remove signal conditioner panel. Refer to paragraph 5-44.

b. Note location of and remove amplifier from signal conditioner panel. Refer to paragraph 5-45.

WARNING

The following procedure specifies naphtha, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

c. Invert amplifier (contacts down), and clean the contacts, using a stiff bristle-brush dipped in naphtha (Federal Specification TT-N-95), or equivalent.

d. Dry contacts with a clean, lint-free cloth or a low flow (10 psig maximum) of gaseous nitrogen (Mil-P-27401).

e. Invert the signal conditioner panel (amplifier connector down), and clean the contacts of the connector from which the amplifier was removed. Use a stiff bristle-brush dipped in naphtha (Federal Specification TT-N-95), or equivalent.

f. Repeat step d to dry connector.

g. Install amplifier in signal conditioner panel (paragraph 5-45).

h. Repeat steps a through g until all amplifiers are cleaned.

i. Install signal conditioner panel (paragraph 5-44).

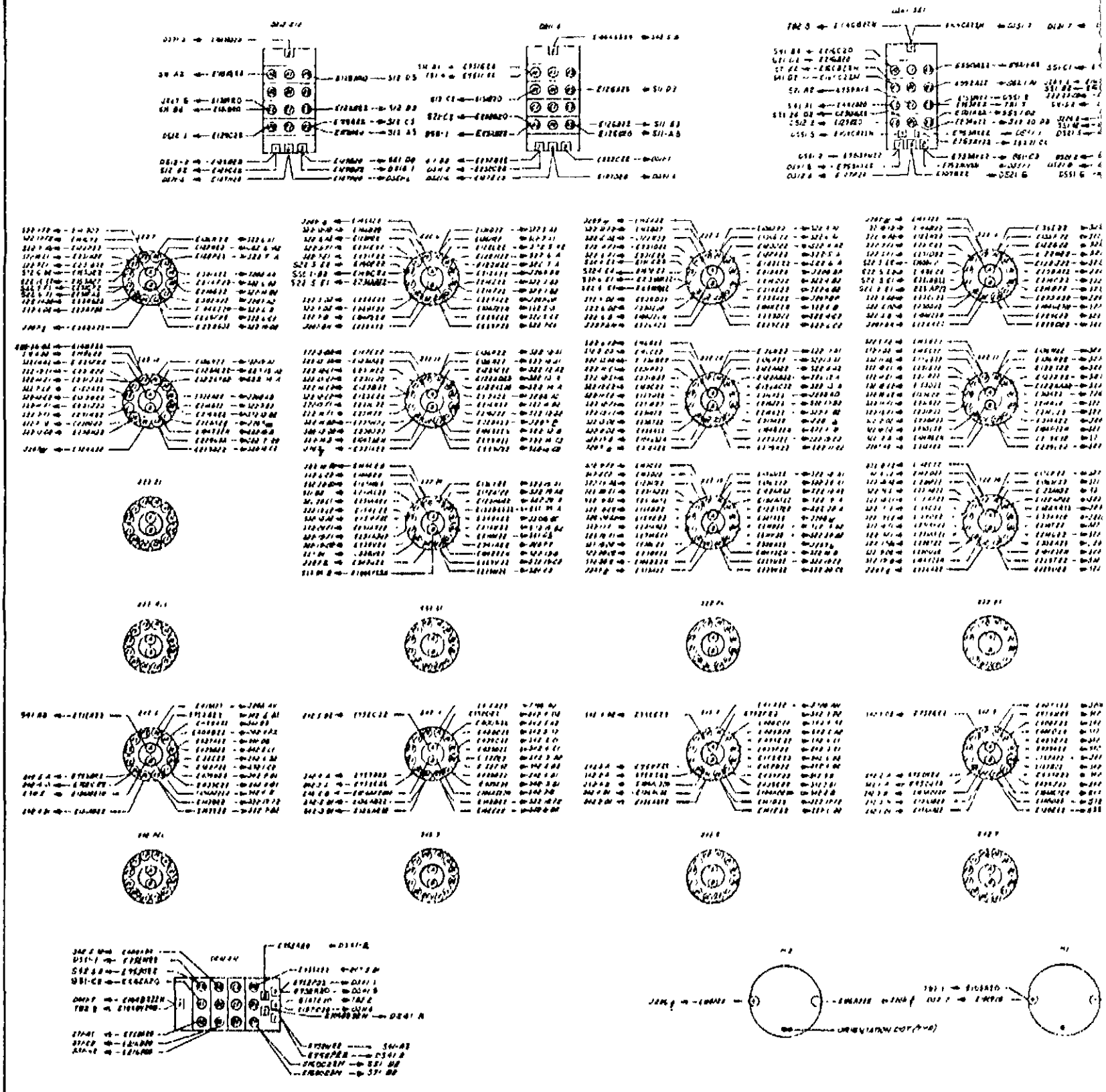
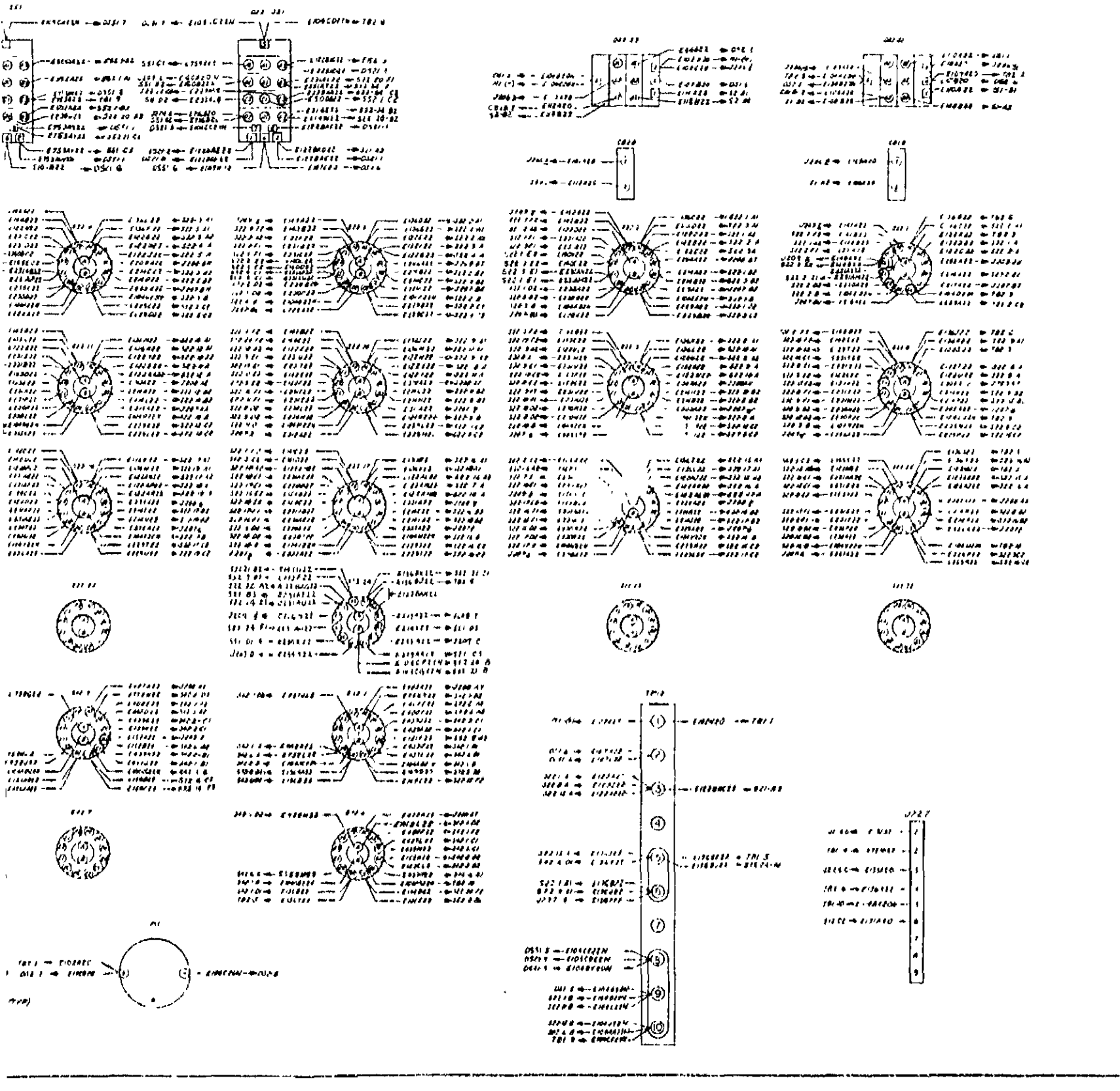
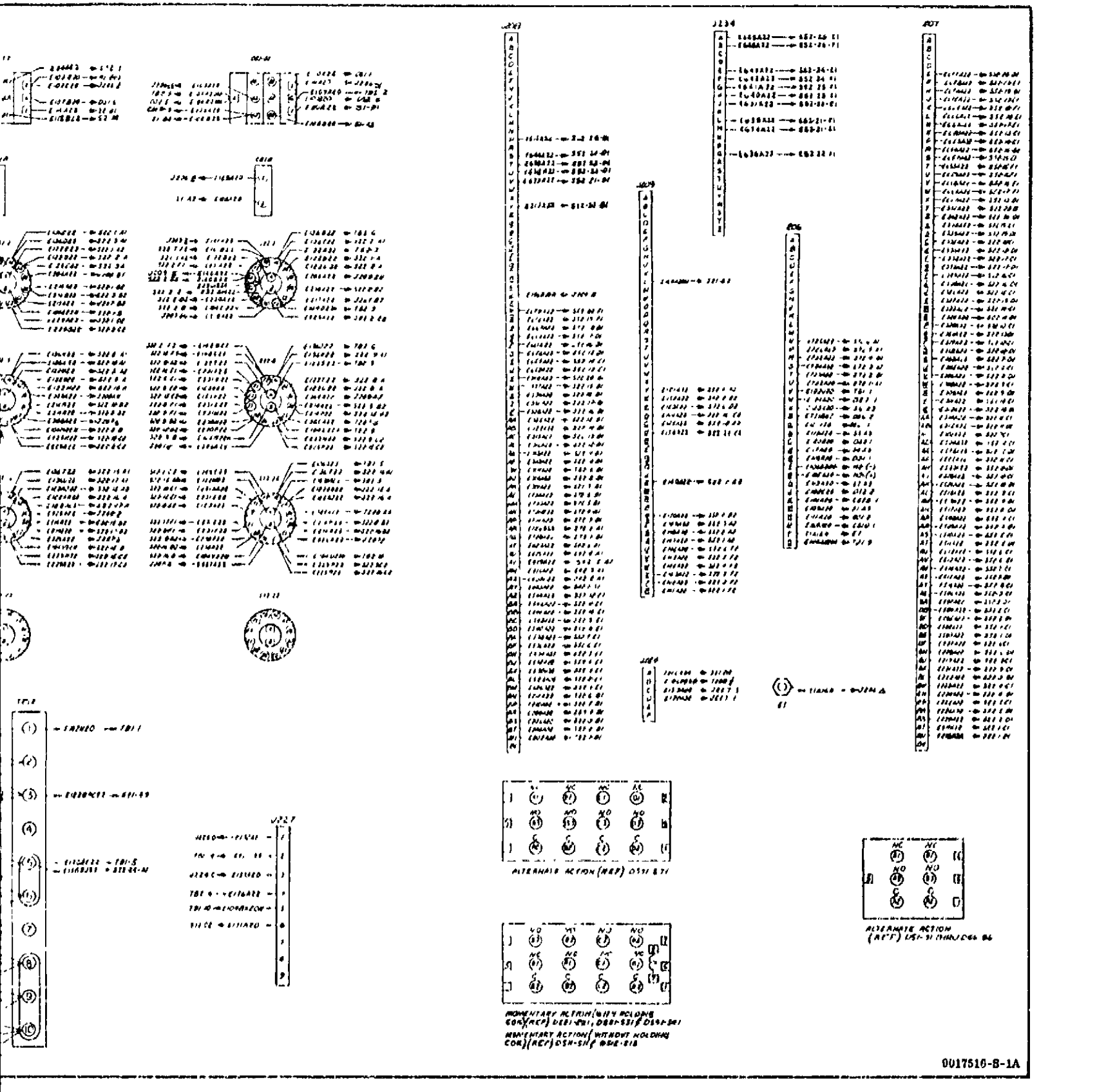


Figure 5-18. Calibration Control Panel Wiring Diagram (Sheet 1 of 2)





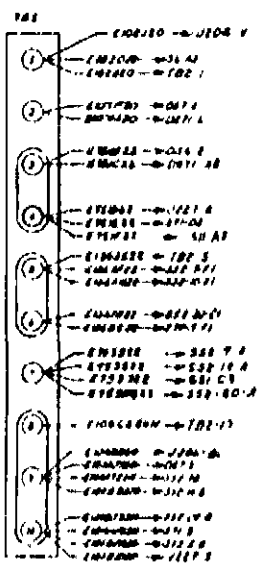
ALTERNATE ACTION (RET) DS11 & T1

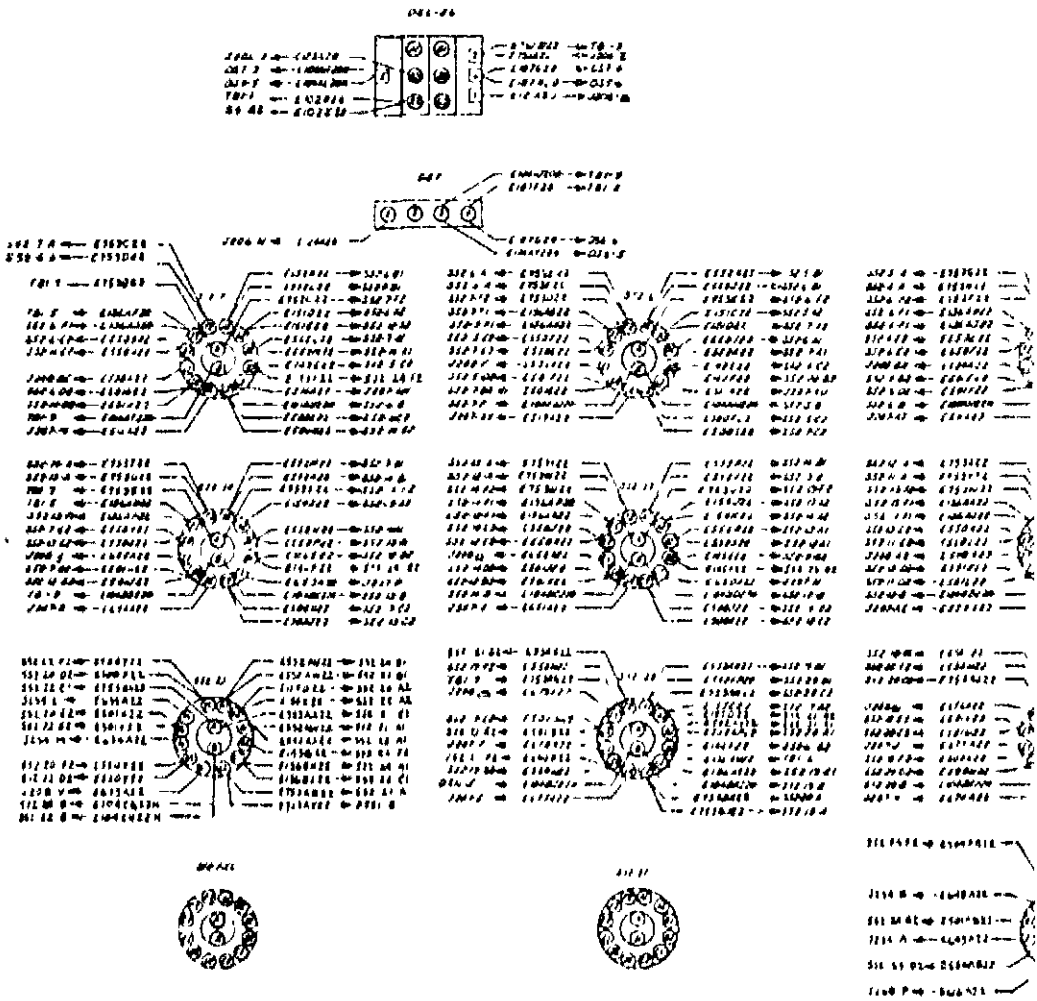
ALTERNATE ACTION (RET) DS11-S1 THRU DS16-S6

MOMENTARY ACTION (WITH HOLDING COIL) (RET) DS81-S81, DS81-S31 & DS14-S61

MOMENTARY ACTION (WITHOUT HOLDING COIL) (RET) DS14-S11 & DS16-S18

0017516-B-1A





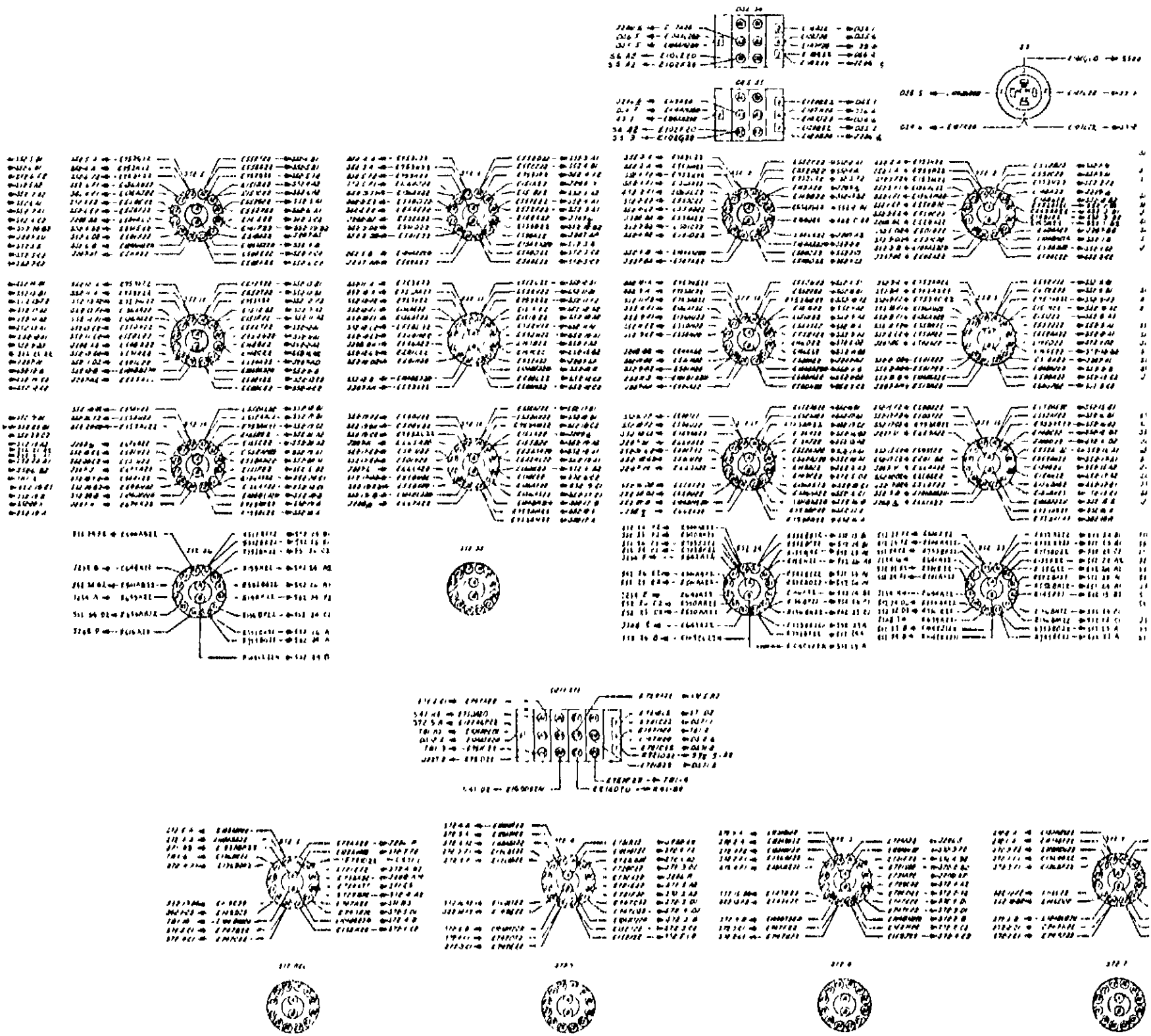


Figure 5-18. Calibrati

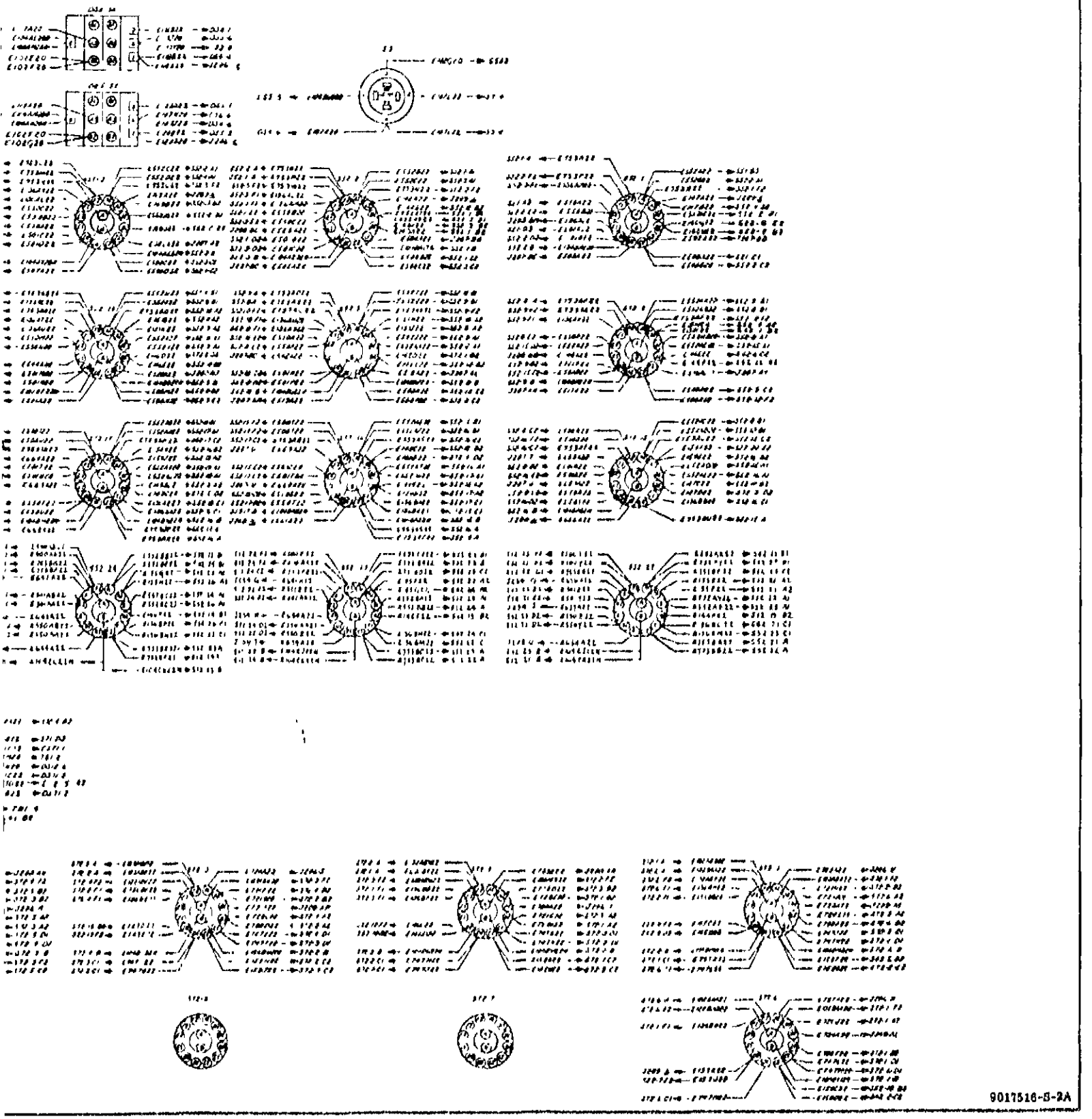


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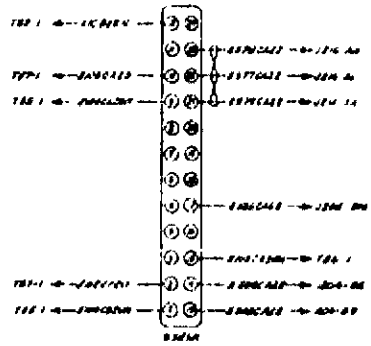
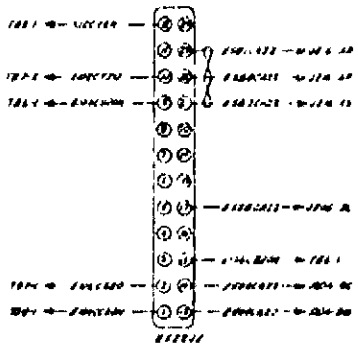
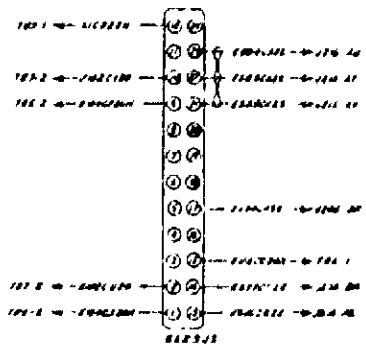
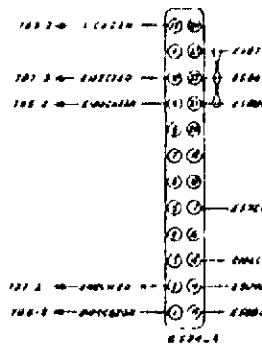
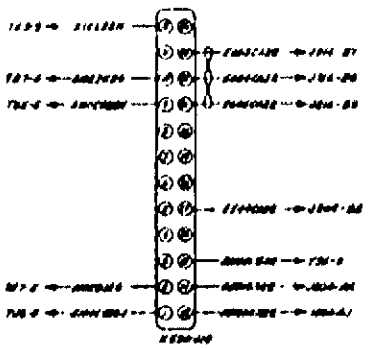
Figure 5-18. Calibration Control Panel Wiring Diagram (Sheet 2 of 2)

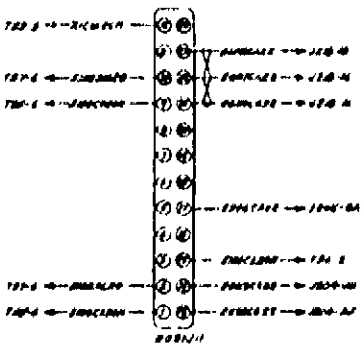


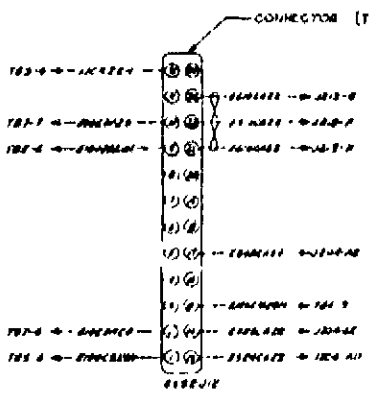








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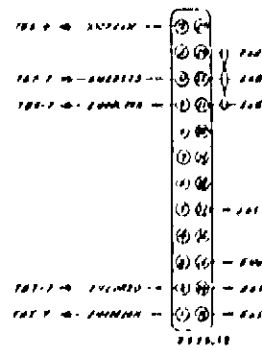

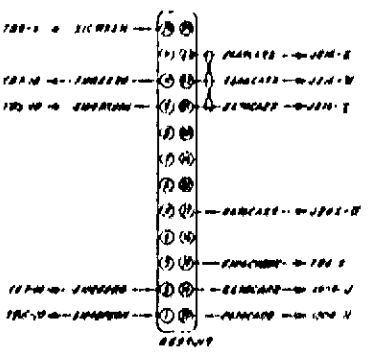

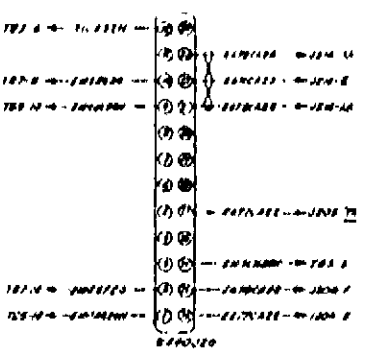

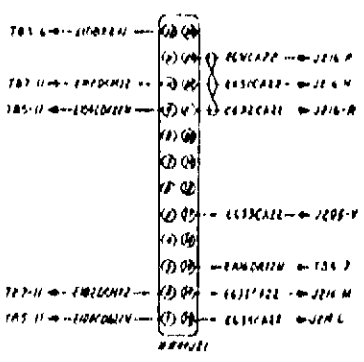

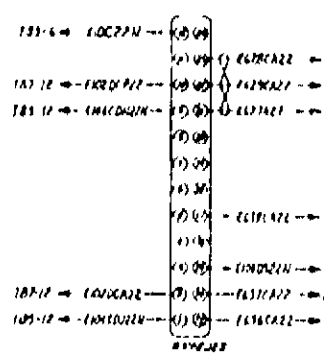

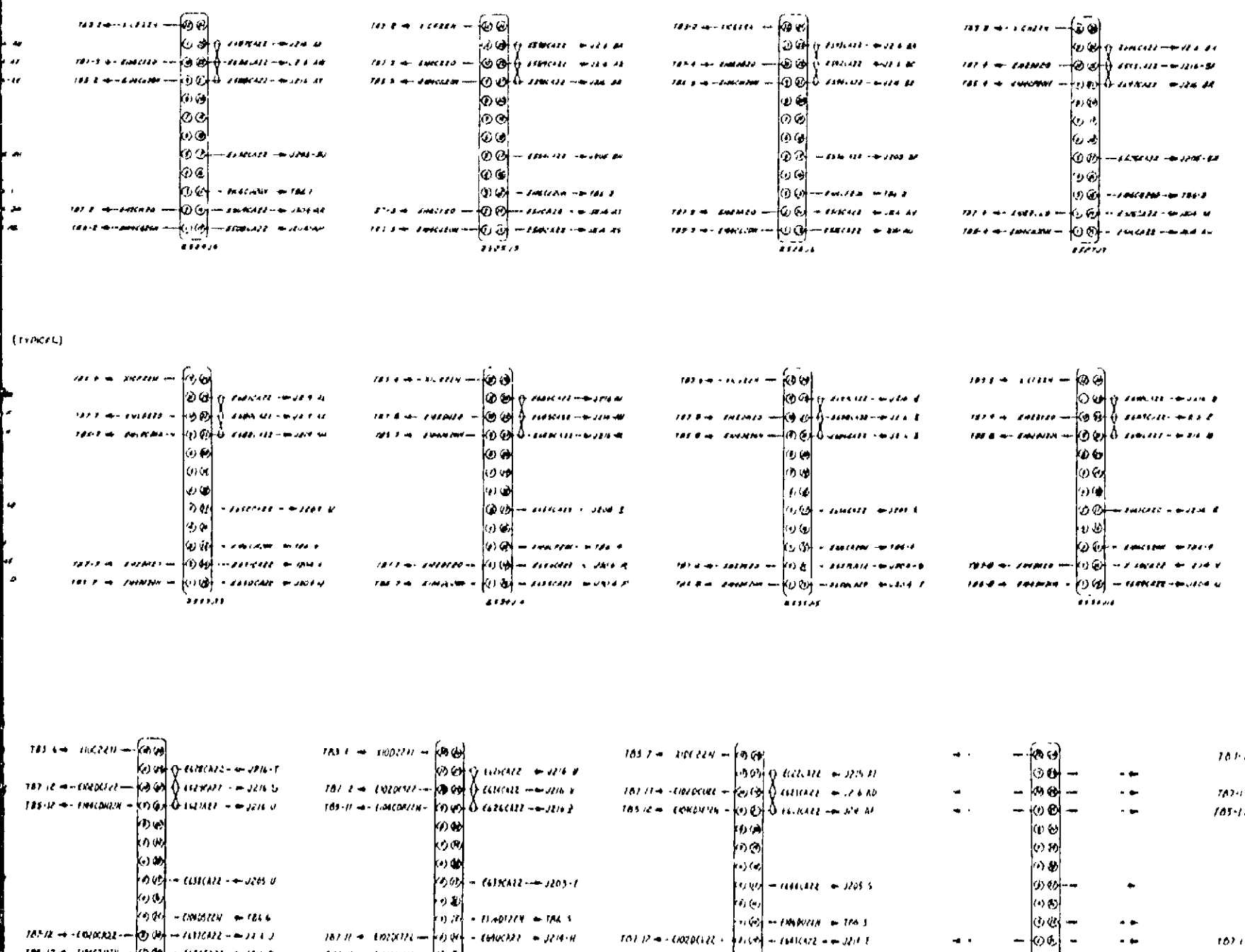

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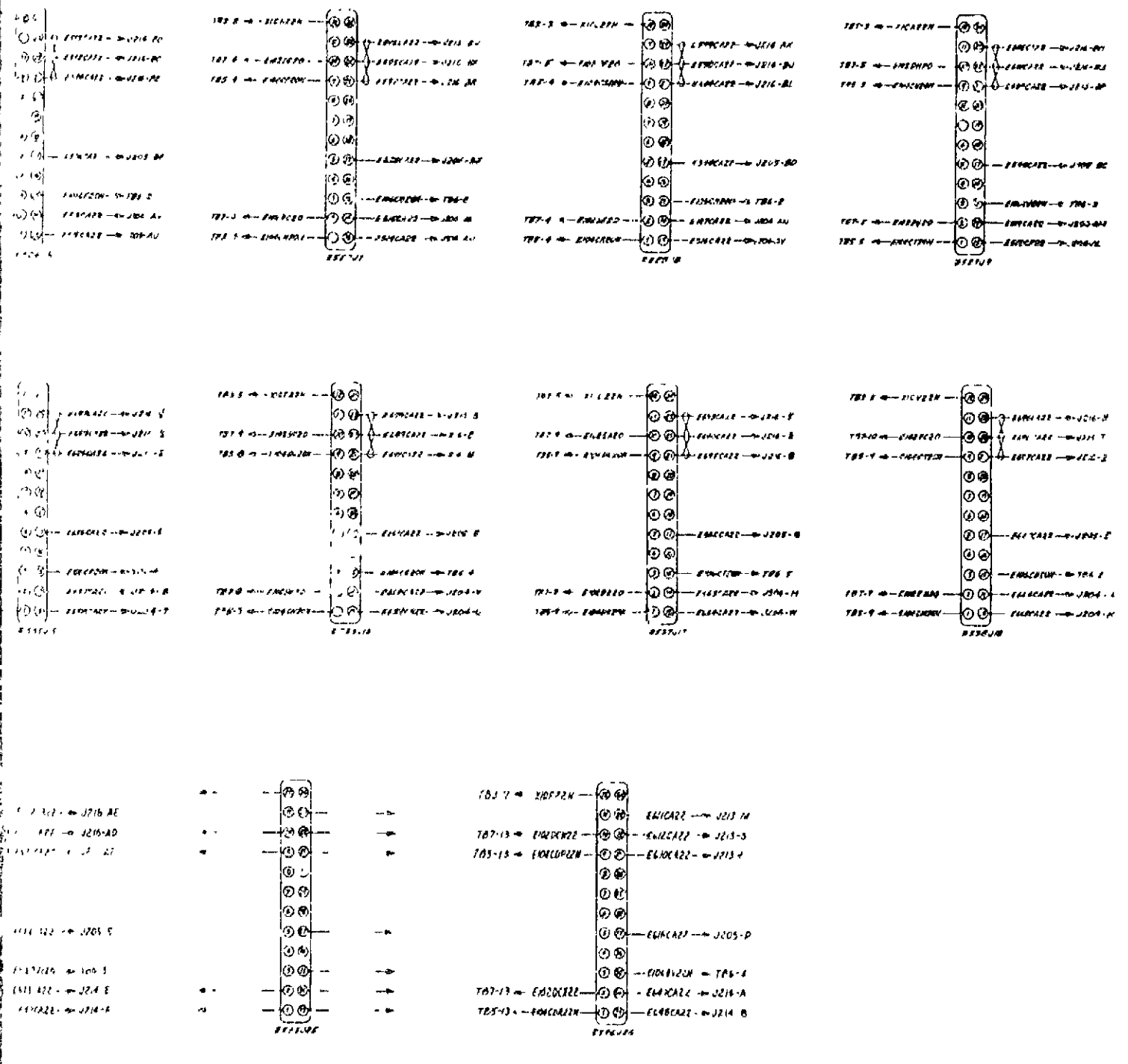

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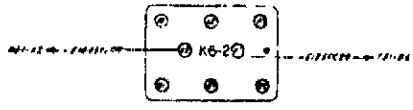
Figure 5-19. Signal Conditioner Panel Wiring Diagram (Sheet 1 of 3)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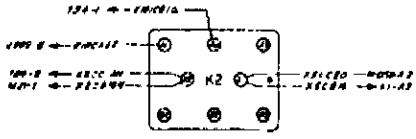
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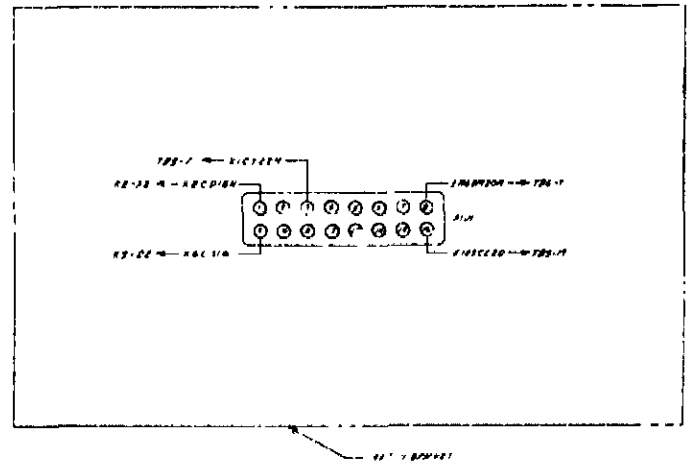

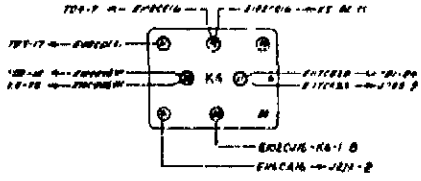
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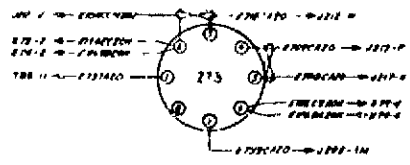
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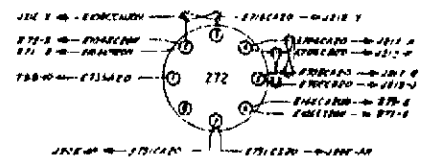
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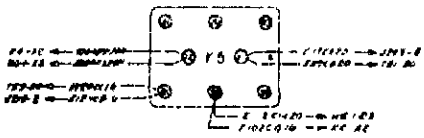
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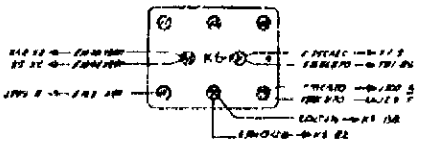
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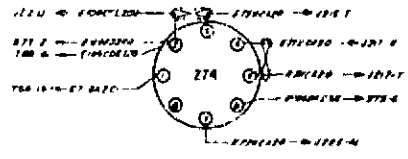
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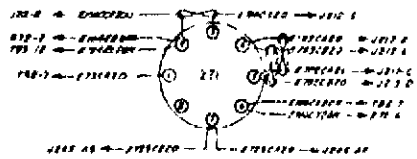
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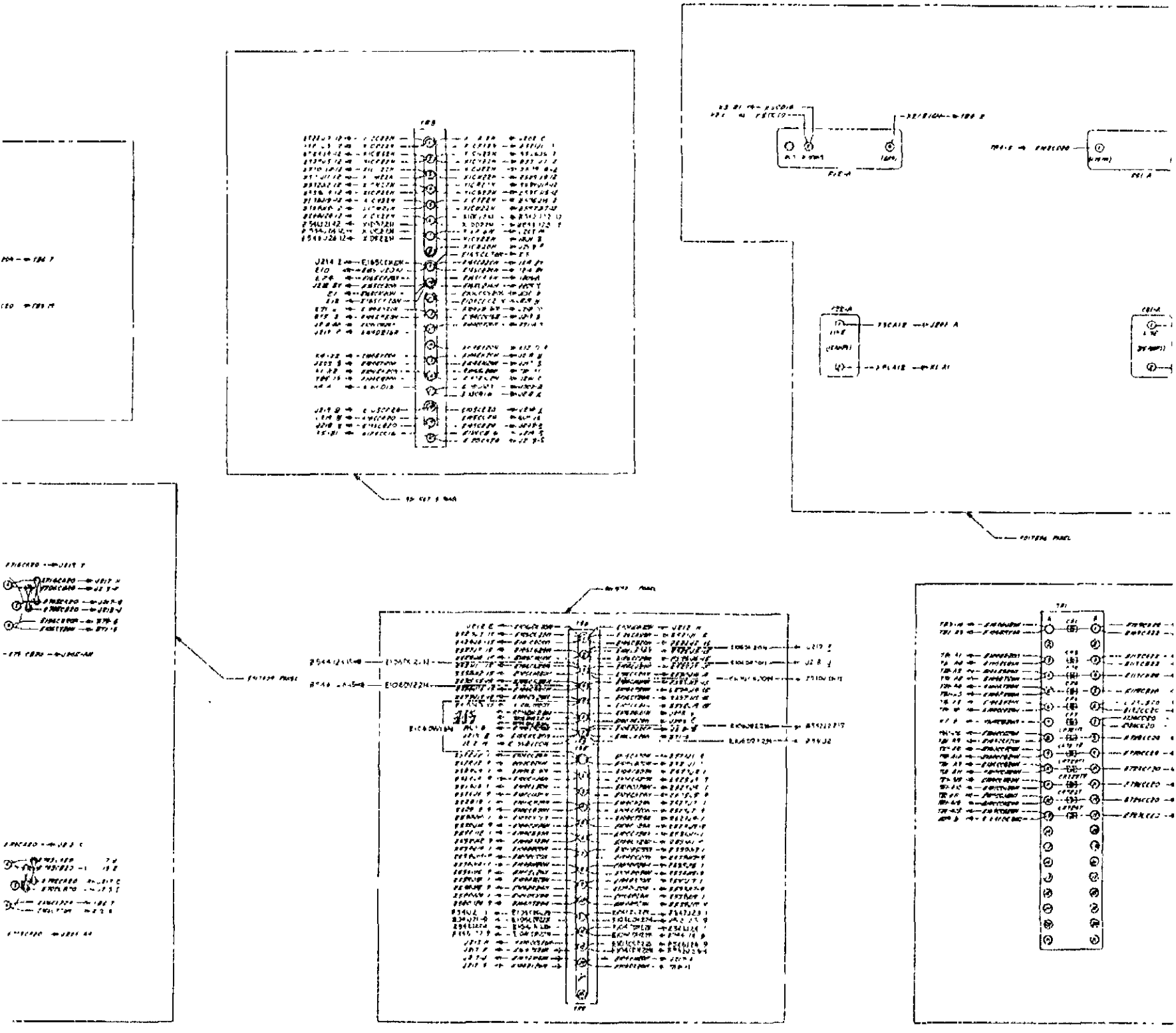

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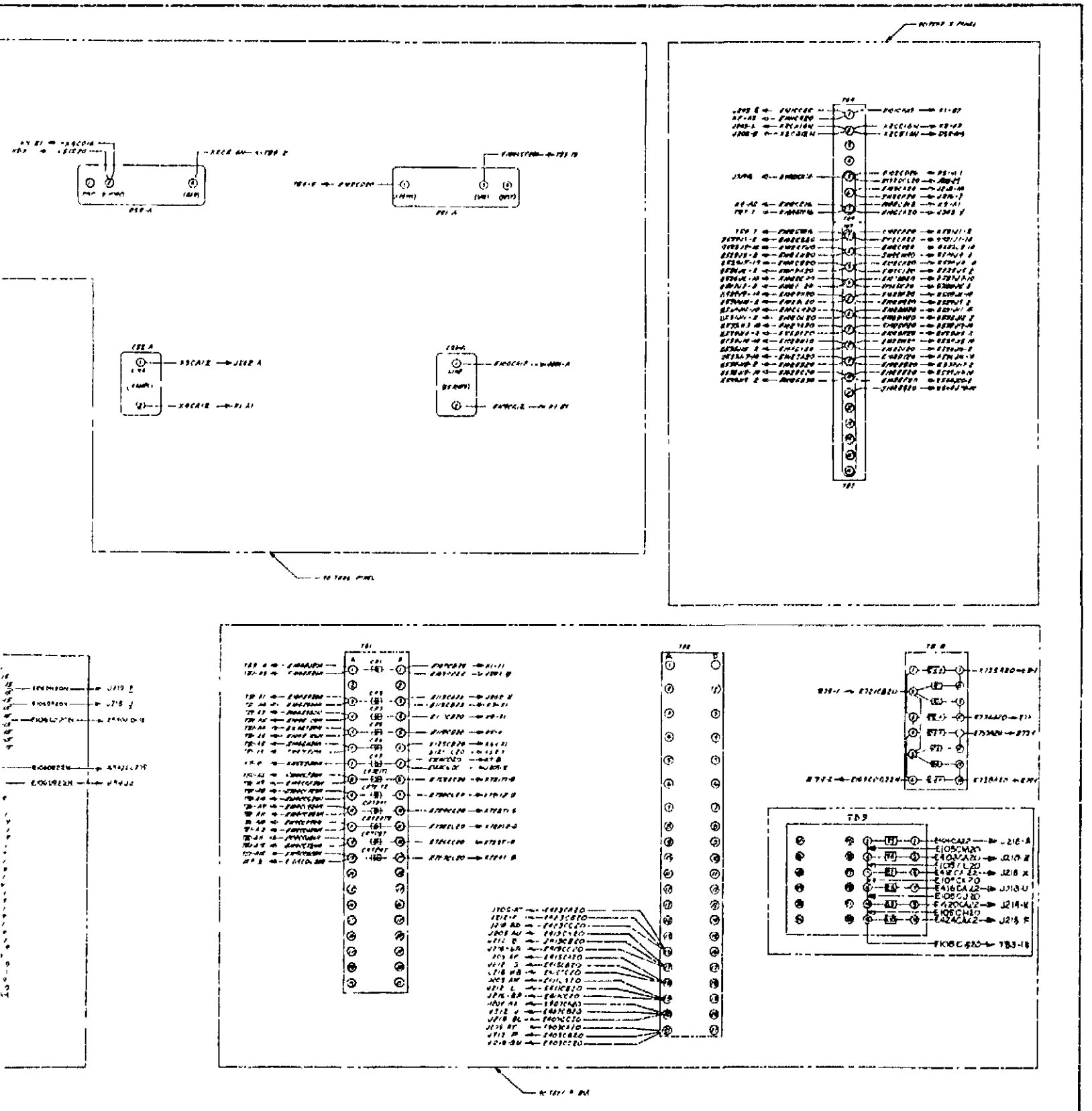
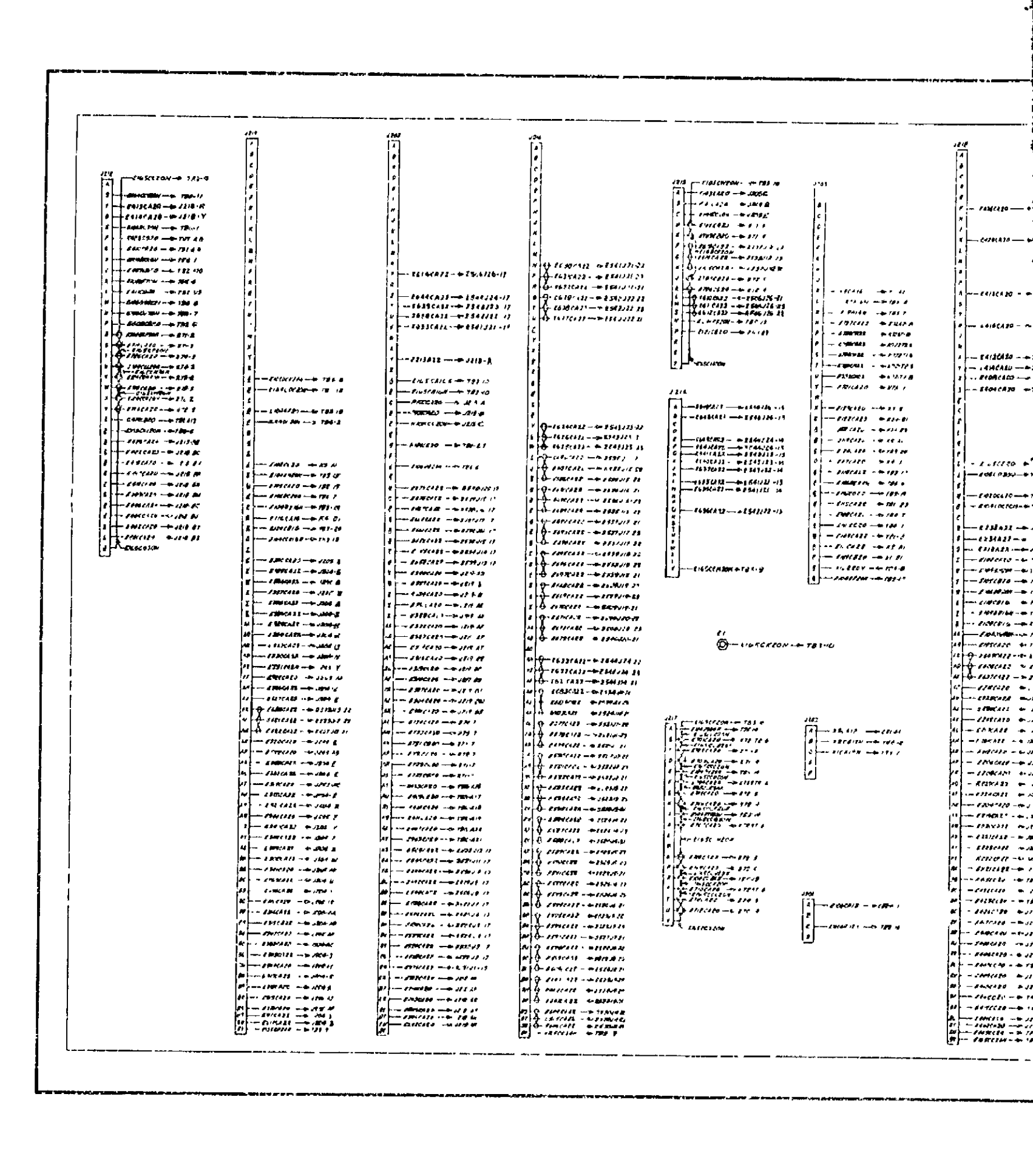
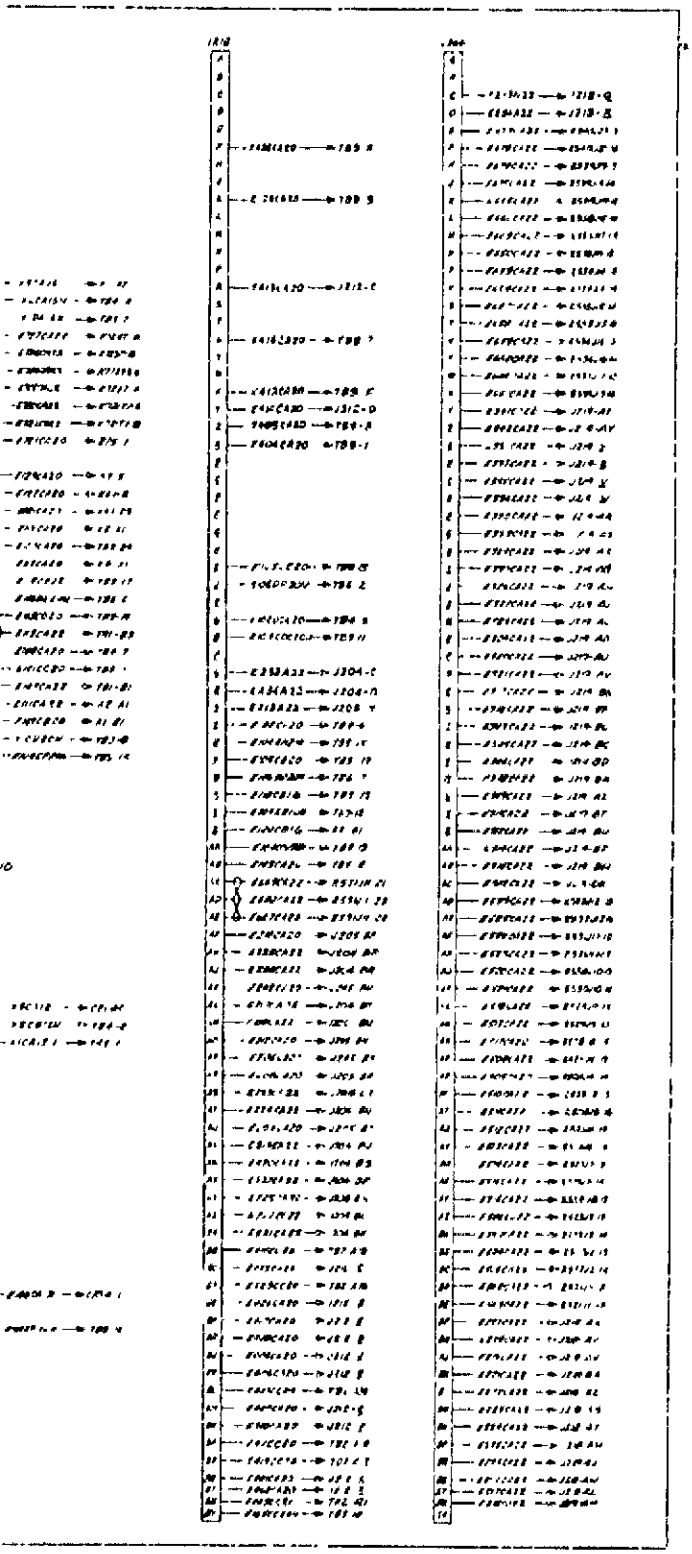


Figure 5-19. Signal Conditioner Panel Wiring Diagram (Sheet 2 of 3)





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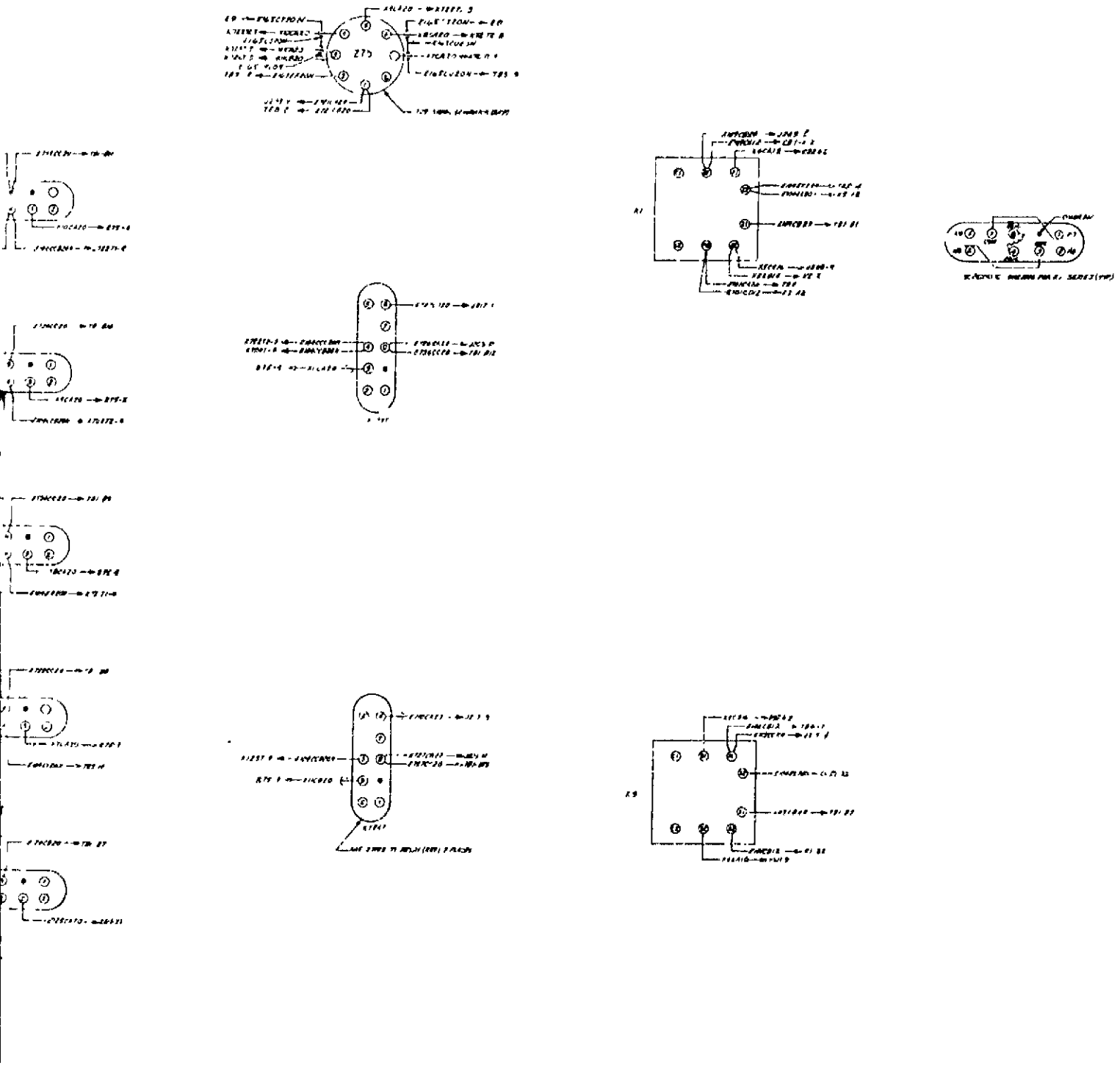


Figure 5-19. Signal Conditioner Panel Wiring Diagram (Sheet 3 of 3)

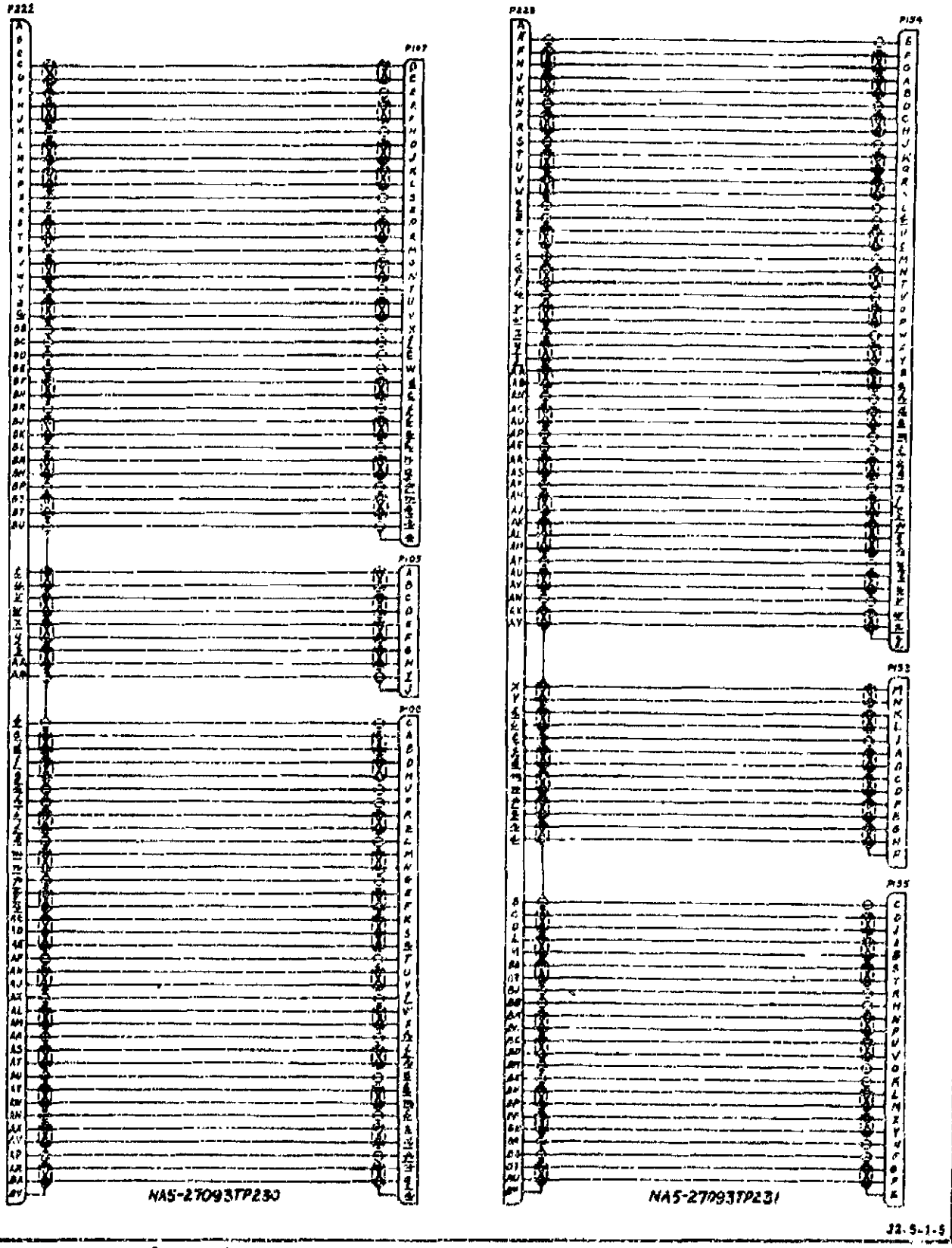


Figure 5-20. Flight Instrumentation Checkout Console External Cables
(Sheet 1 of 4)

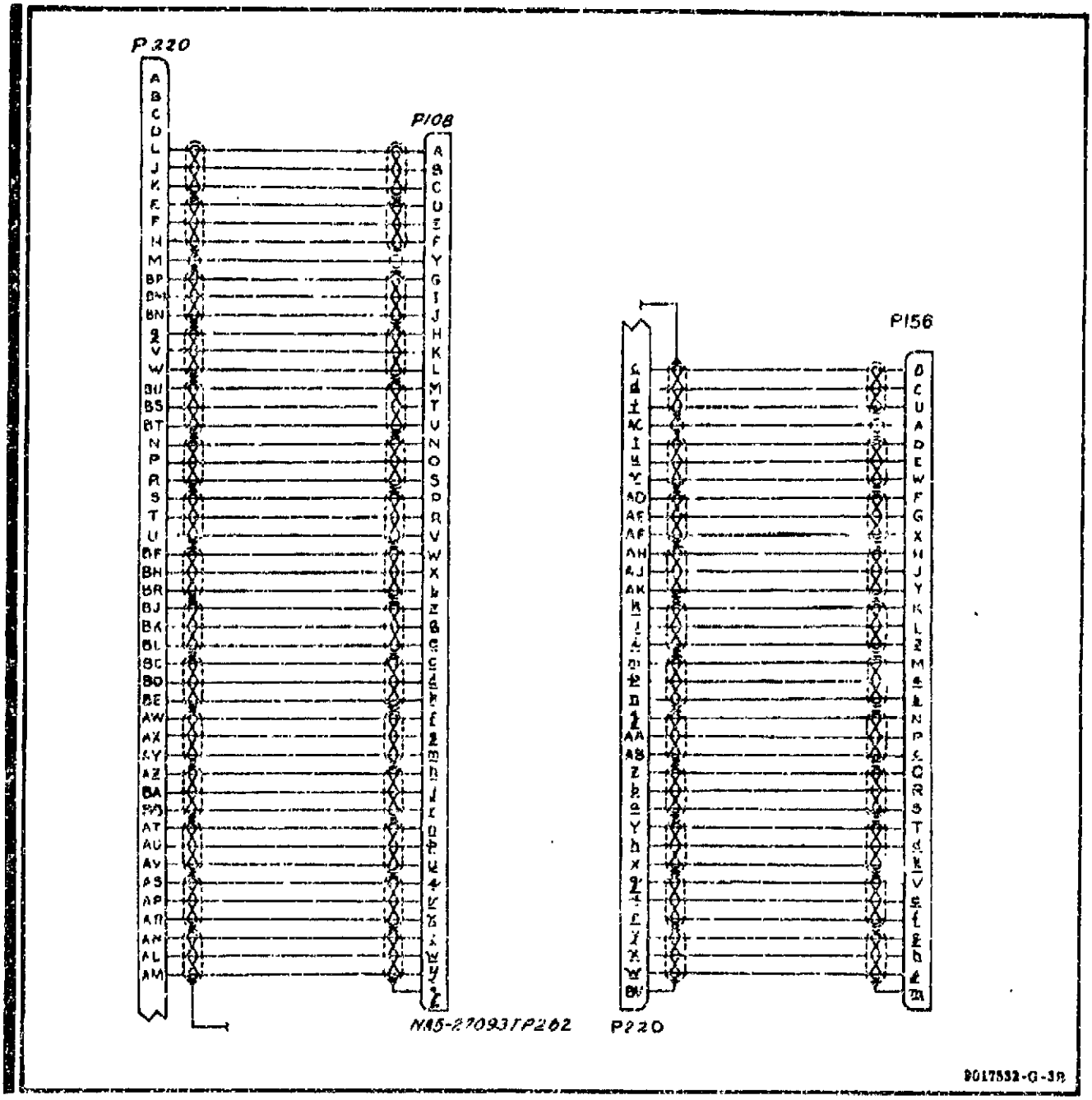


Figure 5-20. Flight Instrumentation Checkout Console External Cables
(Sheet 2 of 4)

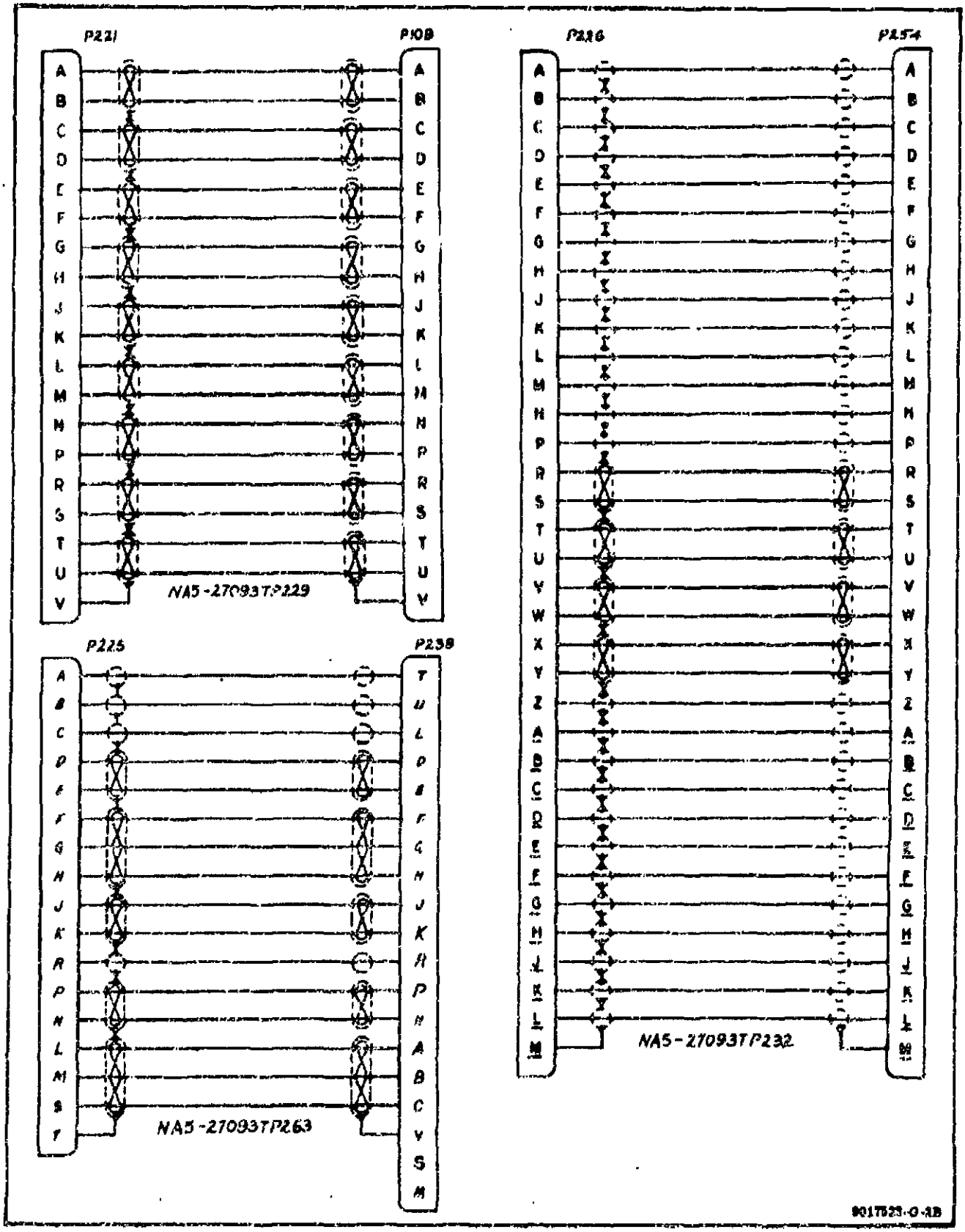


Figure 5-20. Flight Instrumentation Checkout Console External Cables (Sheet 3 of 4)

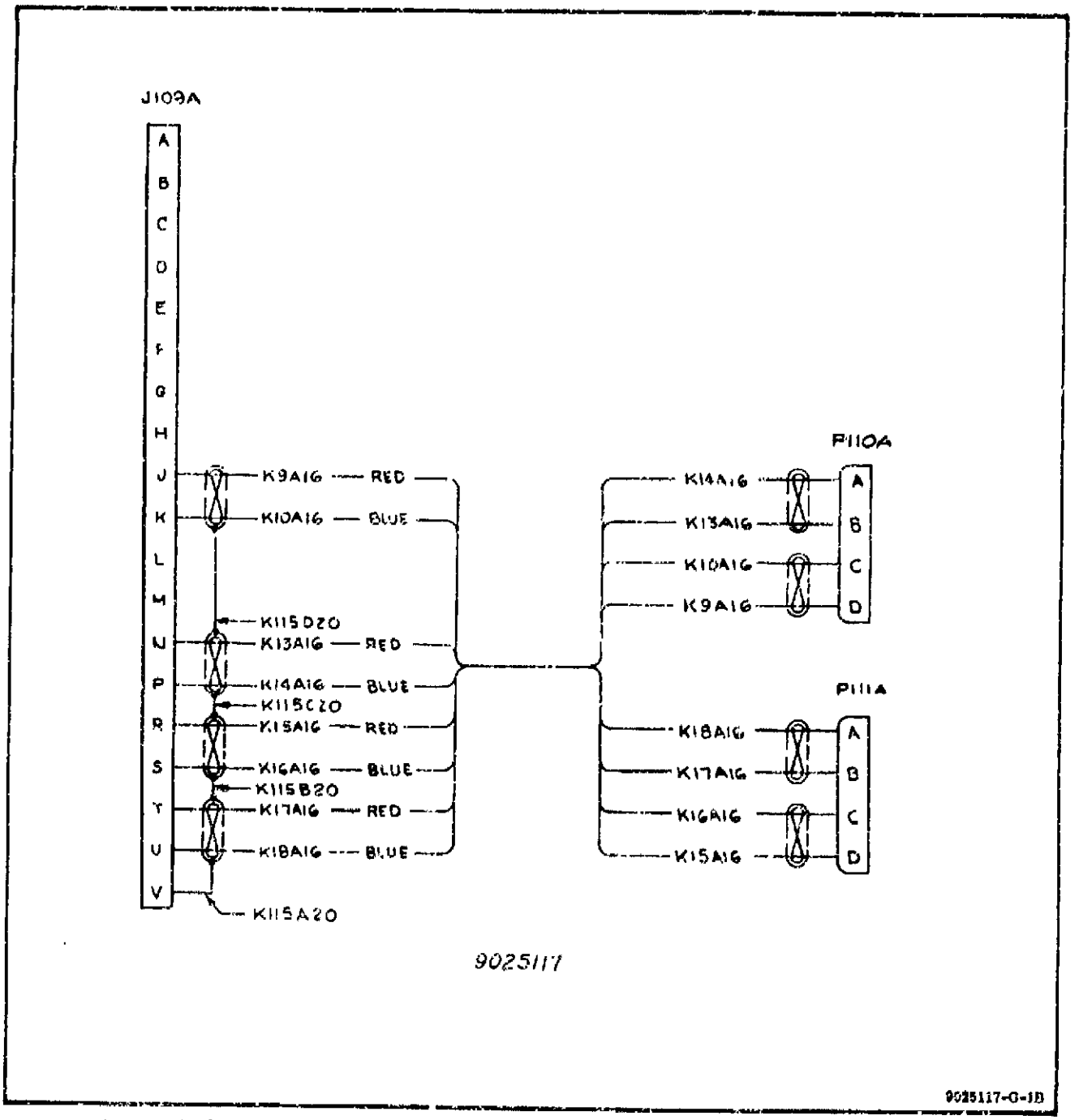
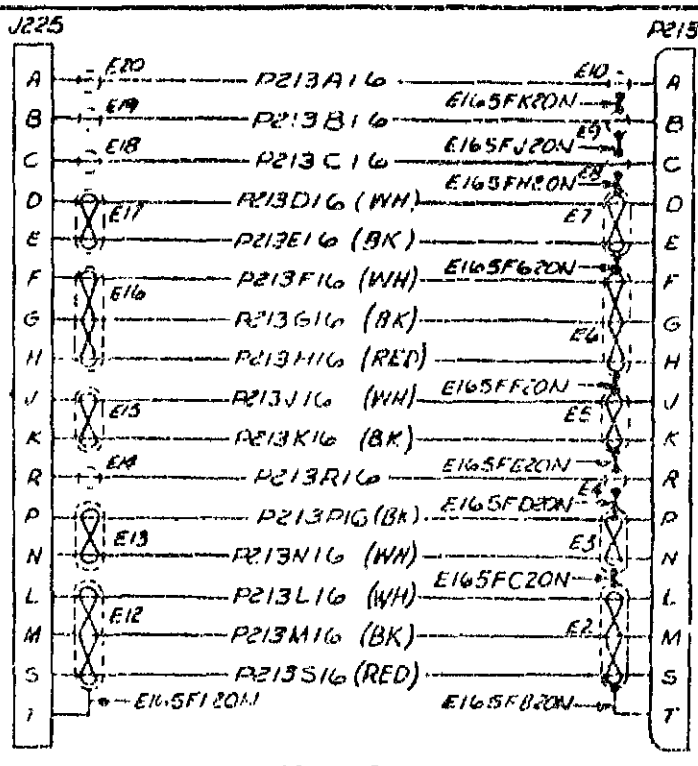


Figure 5-20. Flight Instrumentation Checkout Console External Cables (Sheet 4 of 4)



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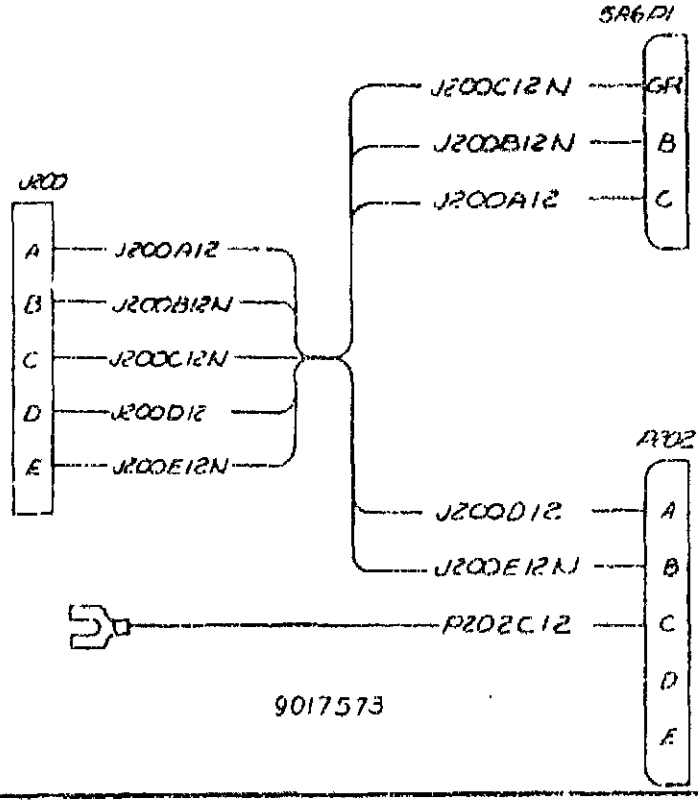

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Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 1 of 8)

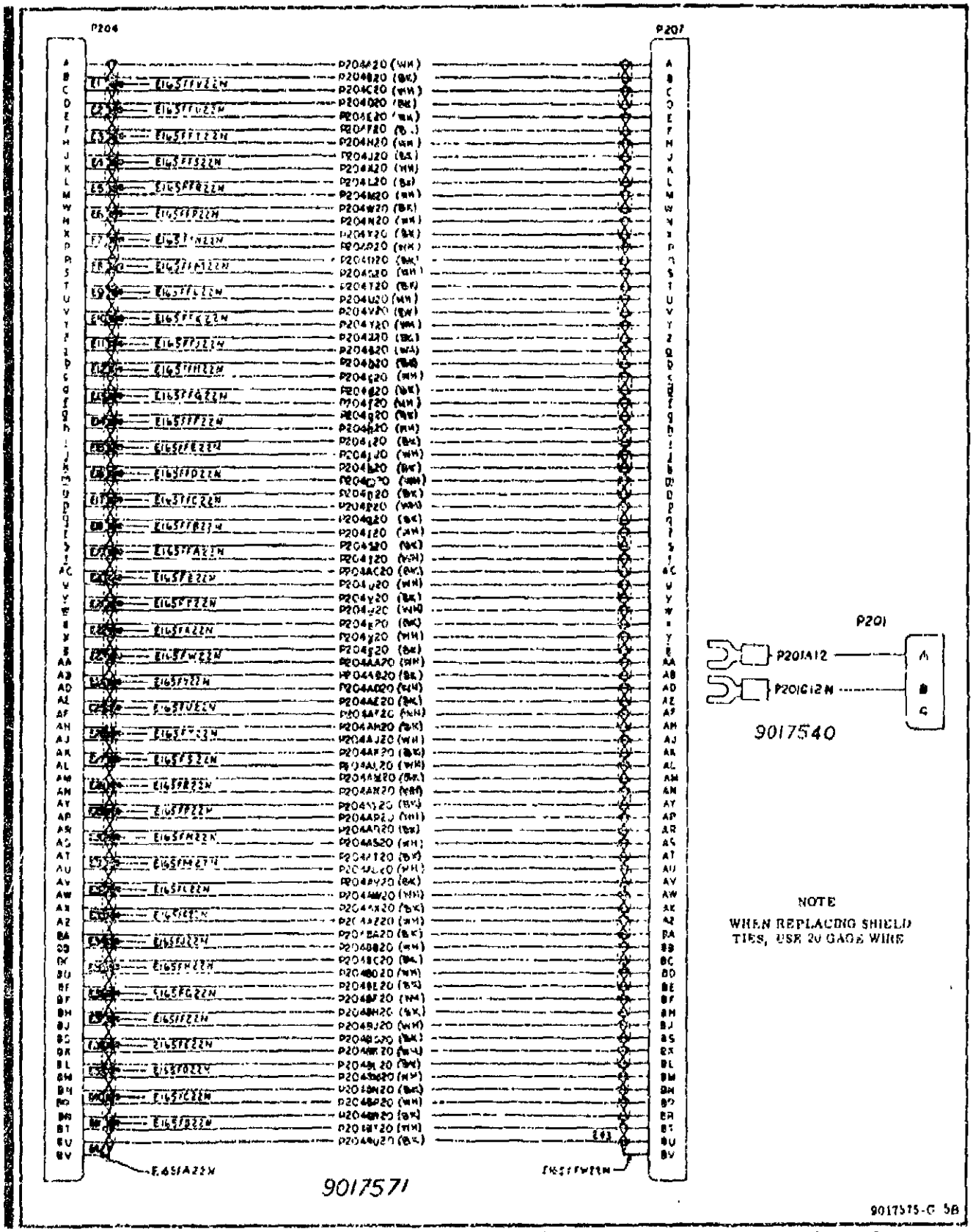

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 2 of 8)

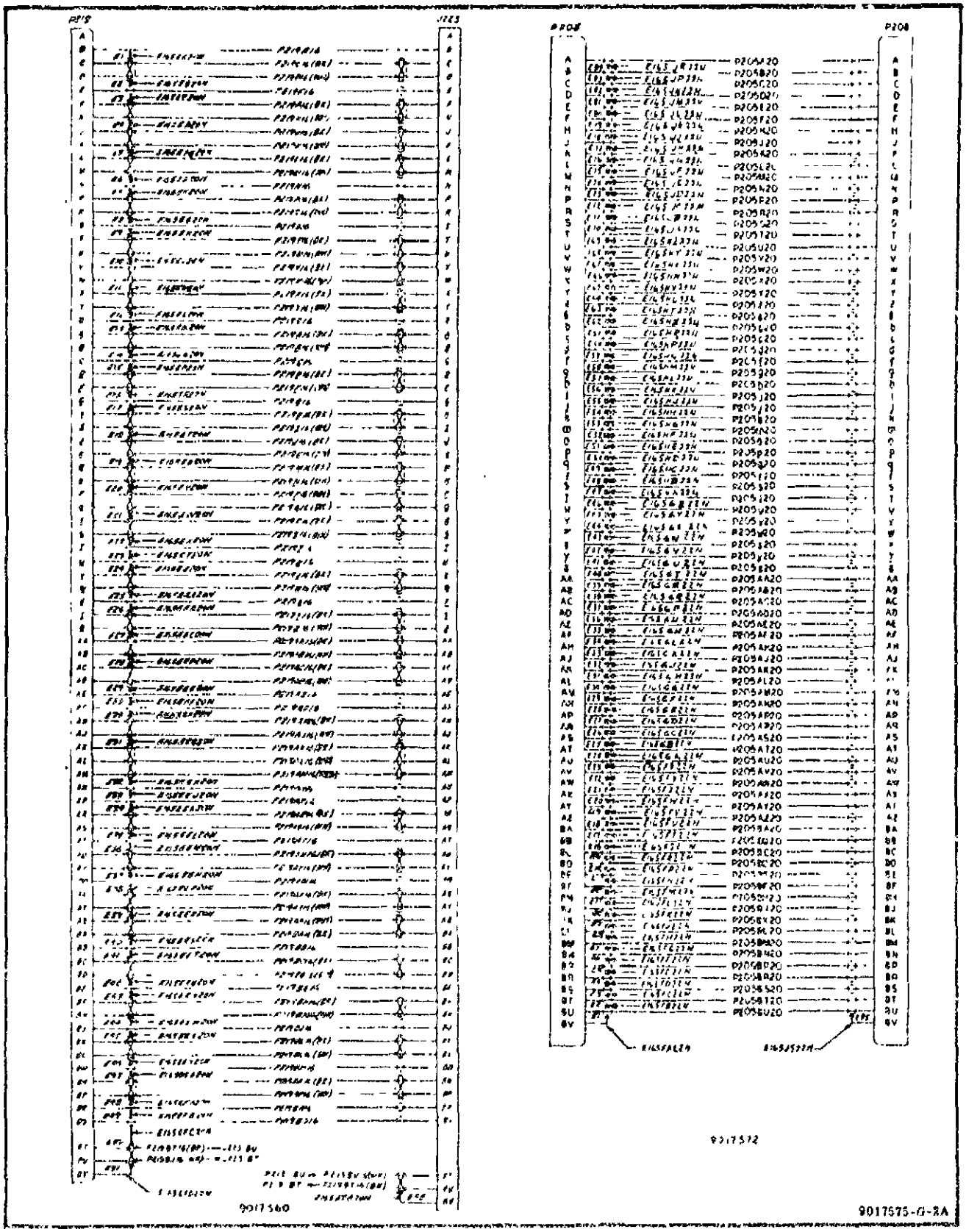

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 3 of 8)

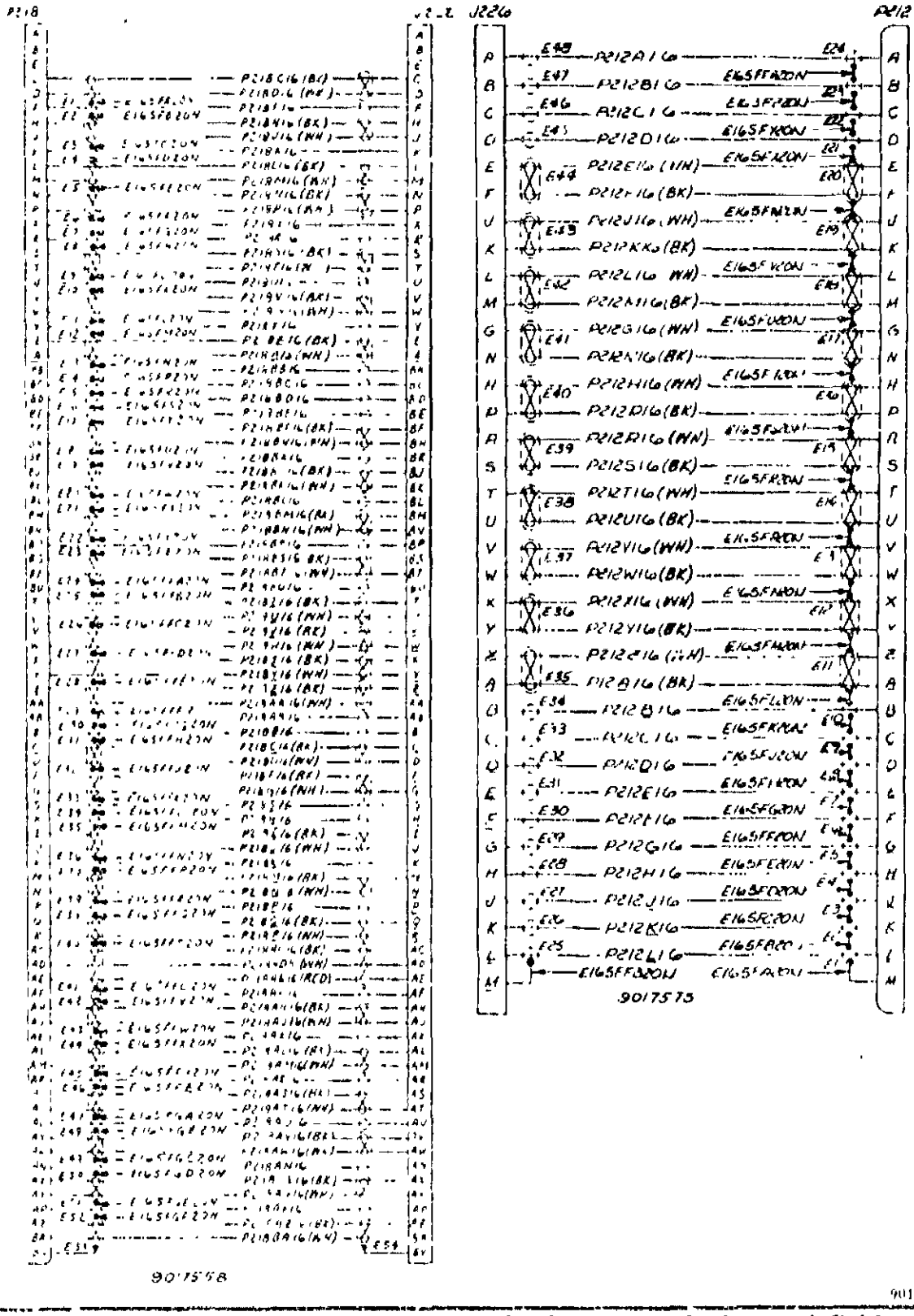

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 4 of 8)

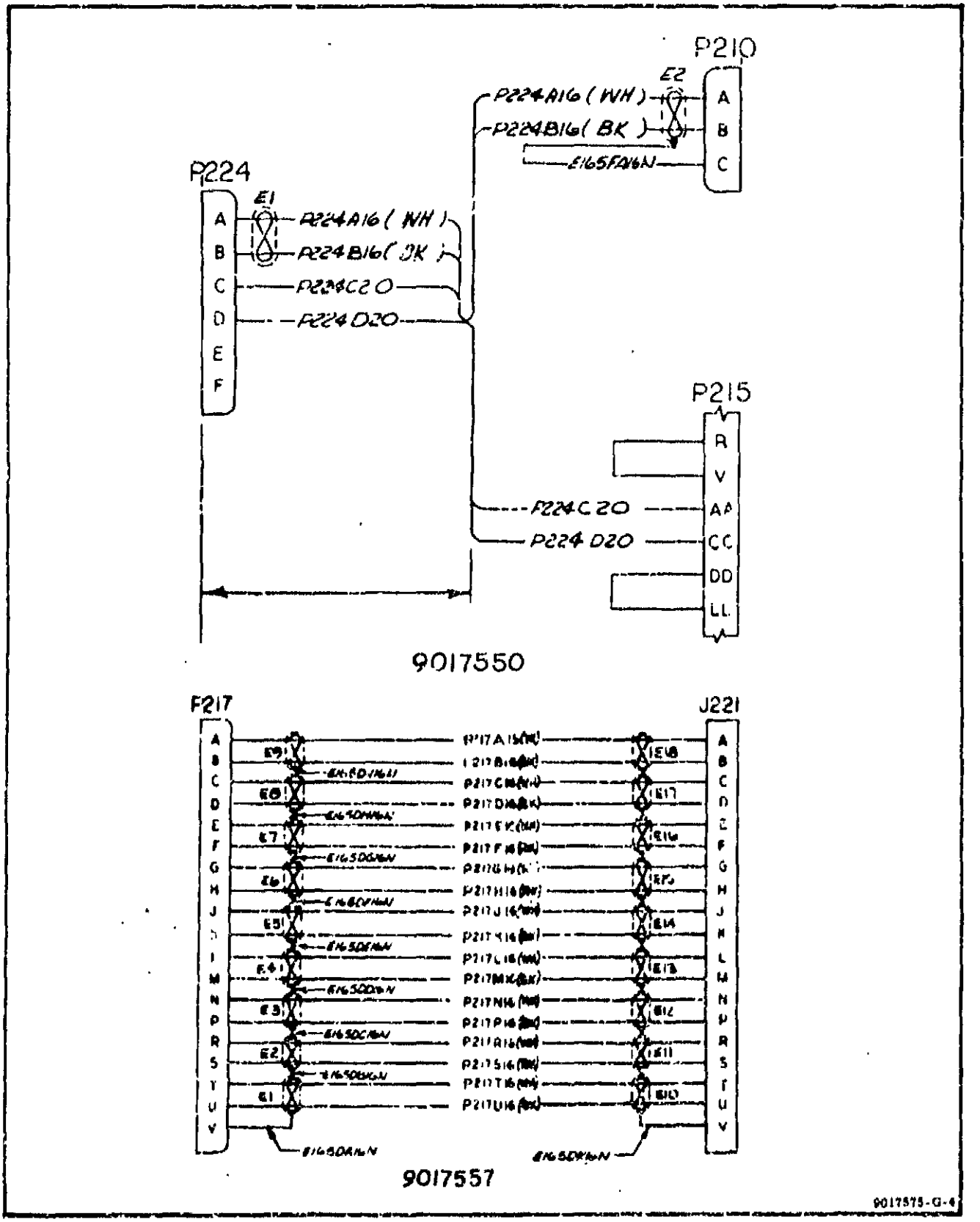

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 5 of 8)

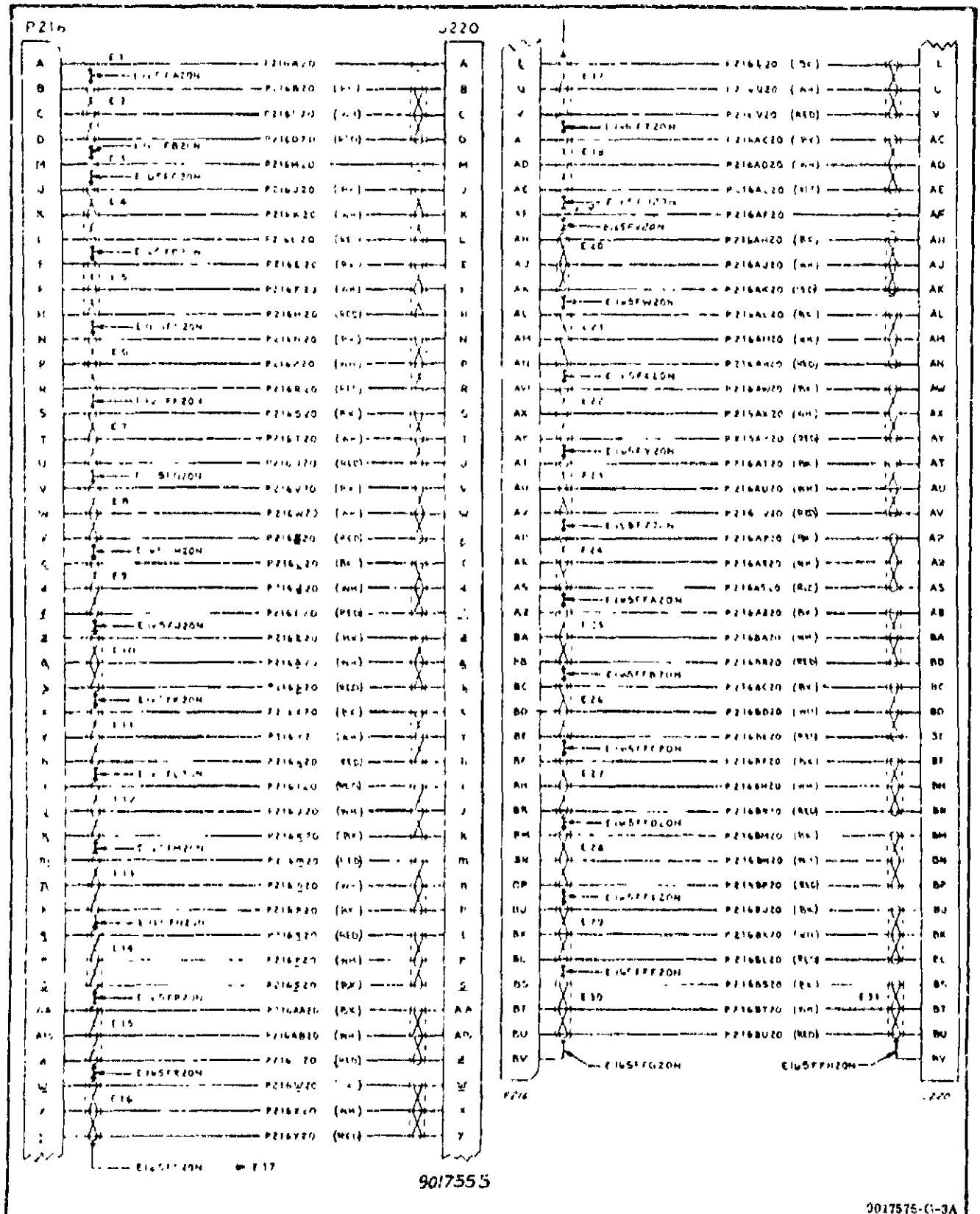

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 6 of 8)

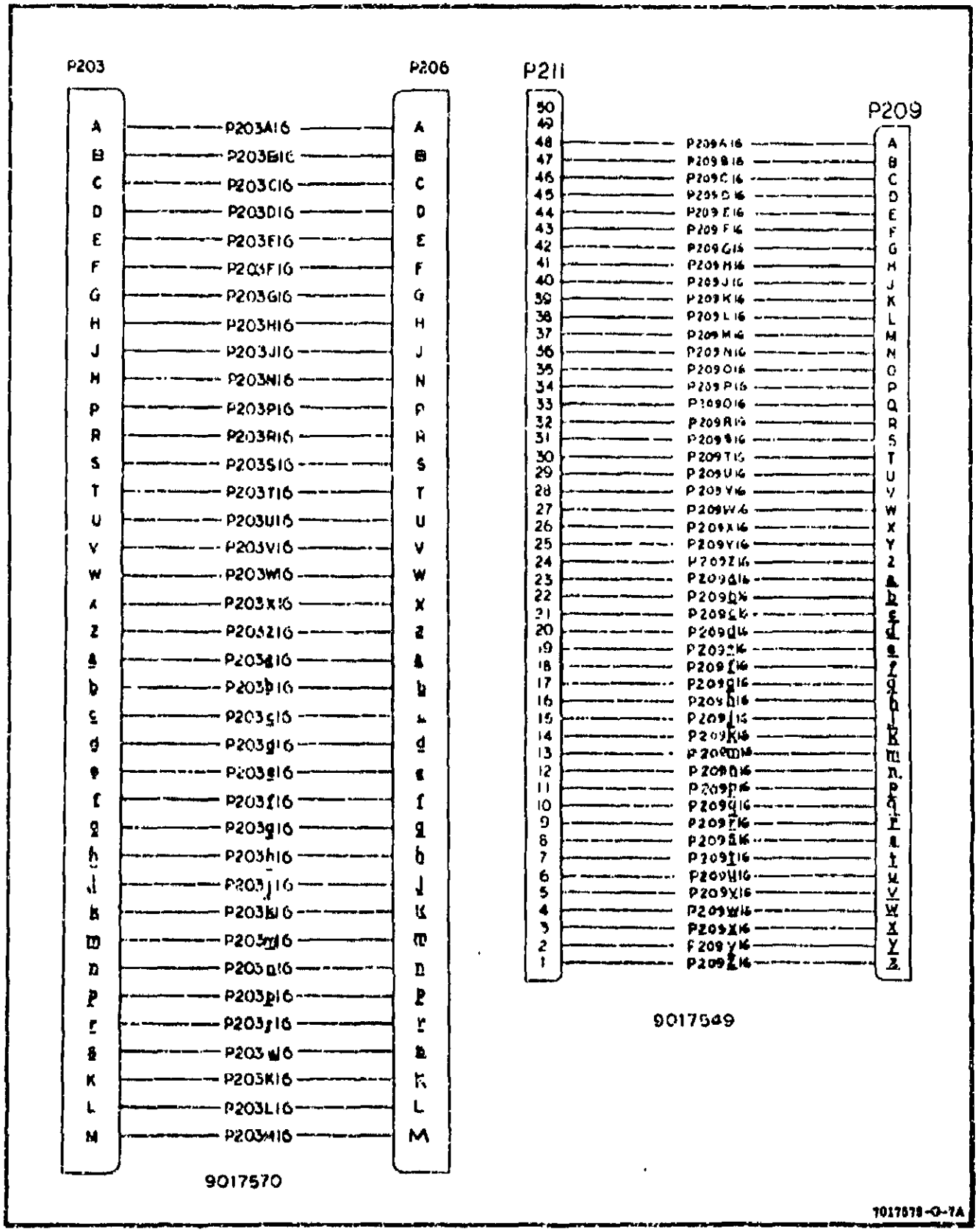

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 7 of 8)

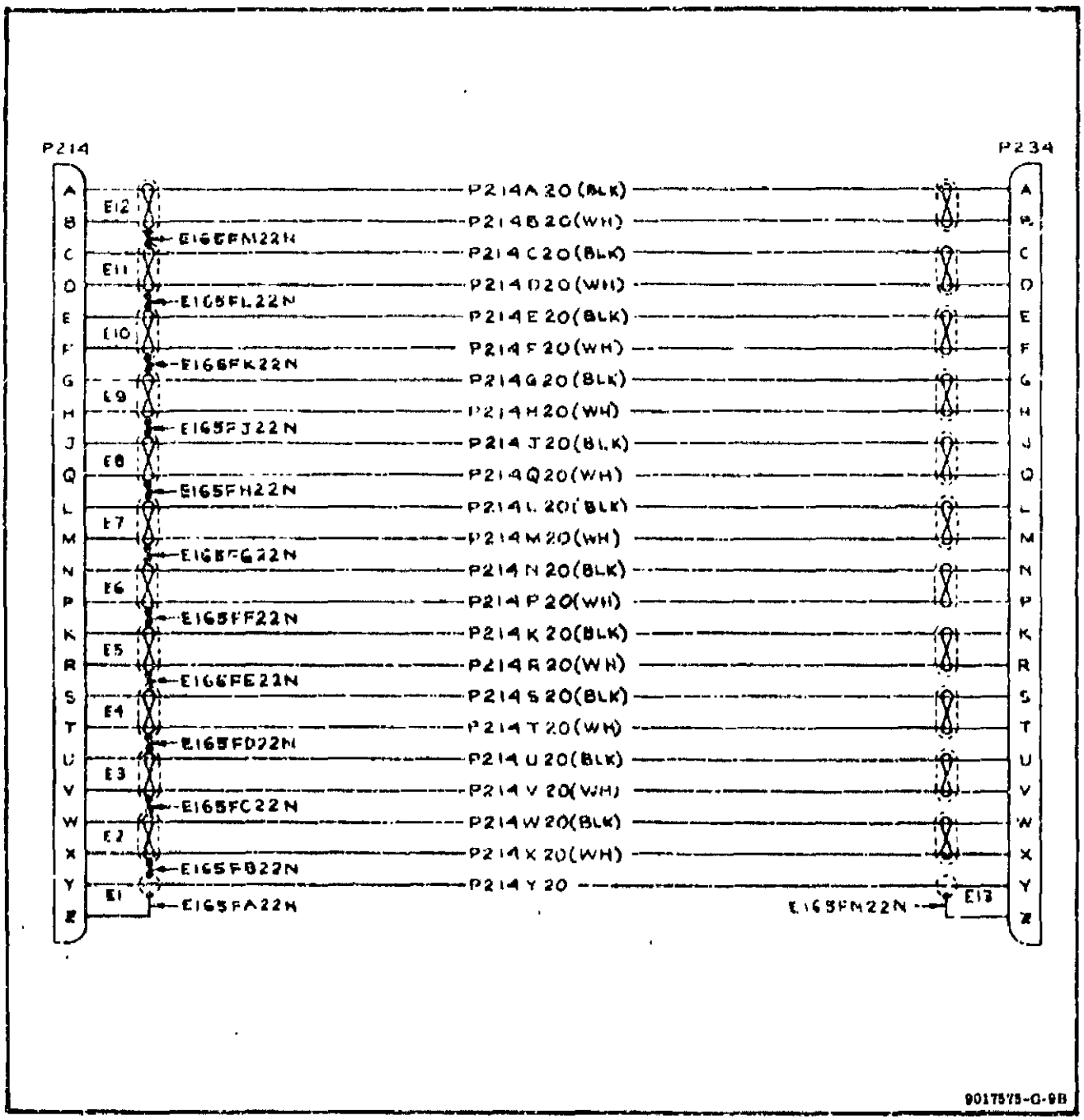

Figure 5-21. Flight Instrumentation Checkout Console Internal Cables (Sheet 8 of 8)

SECTION VI

DATA RECORDER CONSOLE G3121

WARNING

DATA RECORDER CONSOLE G3121 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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6-1. DESCRIPTION AND LEADING PARTICULARS FOR DATA RECORDER CONSOLE.

6-2. The data recorder console (figure 6-1) is an electrical console used to monitor and record engine operational parameters to verify engine acceptability. It also simulates electrical signals to ensure circuit continuity and integrity of Flight Instrumentation Checkout Console G1035 prior to performing a calibration checkout of the engine system. The data recorder console contains a power distribution panel, flight instrumentation simulator panel, interface panel, event recorder, recording oscillograph, and interconnecting cables. The console consists of a cabinet mounted on a base which accommodates forklift handling slots. The base extends forward from the cabinet to increase stability. A door at the

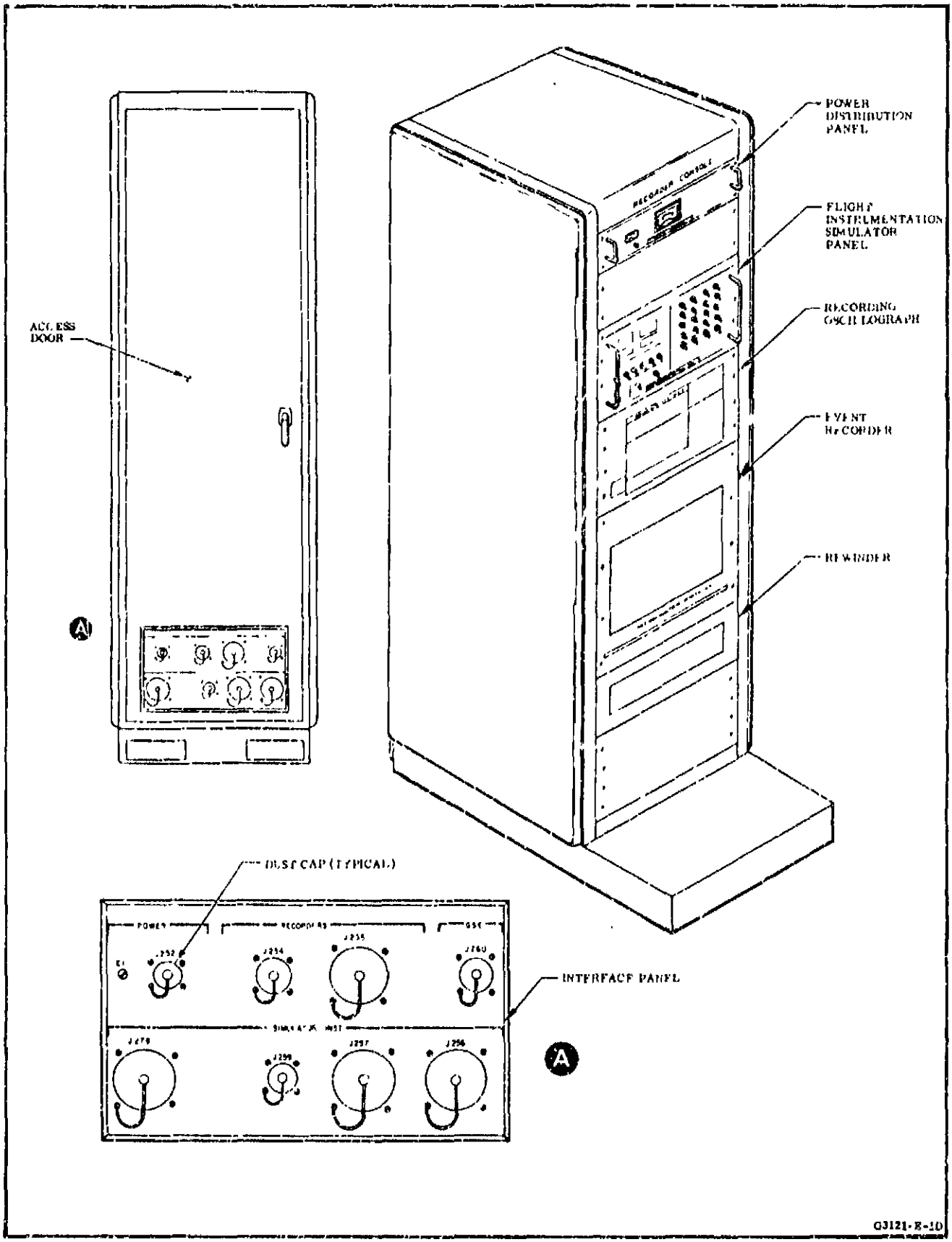


Figure 6-1. Data Recorder Console

rear of the console provides access to electrical panels and interconnecting cables. The interface panel at the lower rear of the console contains receptacles for interconnecting electrical cables from the engine, flight instrumentation checkout console, and facility electrical power. The interconnecting cables are stored in the console. See figure 6-2 for leading particulars of the console. Instructions for use of the console are in Technical Manuals R-3825-3, Volume I and R-3825-2.

Dimensions	
Height	78.5 inches
Width	22.6 inches
Depth	25.6 inches
Weight	738 pounds
Power Requirements	
Alternating Current	115 ±10 volts, single-phase, 60-cycle, to interface receptacle J252, pin A positive, pin B neutral, and pin C chassis ground
Ampere Rating	15 amperes
Facility Power Cable Connector Requirement	Mating connector to J252, MS3106B-18-11S, or equivalent

Figure 6-2. Leading Particulars for Data Recorder Console

6-3. POWER DISTRIBUTION PANEL.

6-4. Power distribution panel 9025088 (figure 6-3) is an electrical system capable of supplying 115-vac power to the event recorder and oscillograph. It is located at the top of the console and contains a circuit breaker, 115-vac power indicator light, ac voltmeter, and electrical connectors. The circuit breaker, light, voltmeter, and electrical connectors are wired to the internal terminal boards on each side of the chassis. The panel is 19.0 inches wide, 4.4 inches deep, 5.2 inches high, and is secured to the front of the console by four screws.

6-5. FLIGHT INSTRUMENTATION SIMULATOR PANEL.

6-6. Flight instrumentation simulator panel 9024510-11 or 9025108-21 (figure 6-4) is an electrical panel capable of simulating engine instrumentation parameters for self-checkout of the flight instrumentation checkout console before engine calibration. It contains switches, indicator lights, electrical receptacles, and resistor terminal boards. The terminal boards are installed on brackets inside the panel and serve as connecting points between the receptacles, switches, and indicator

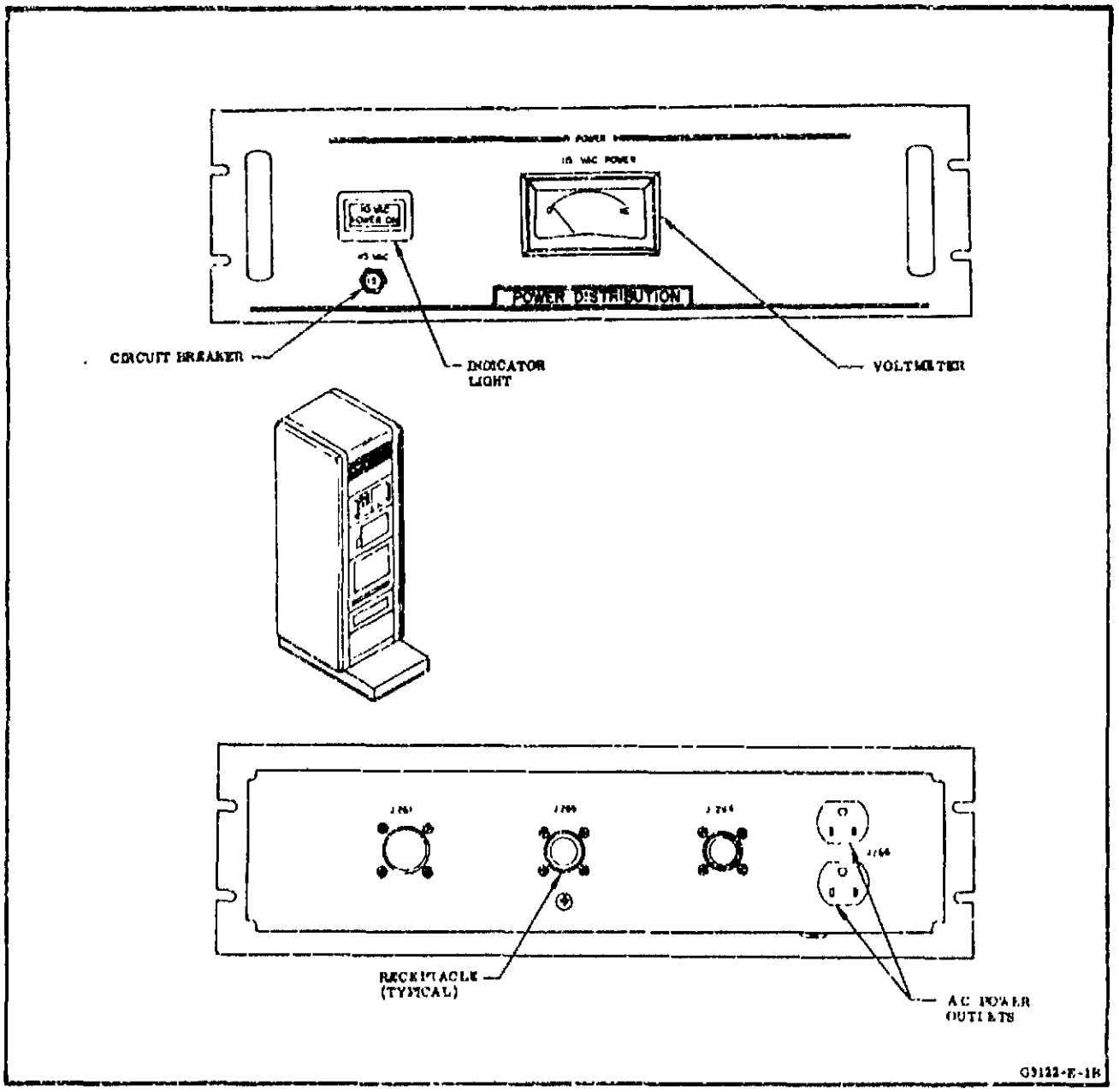


Figure 6-3. Power Distribution Panel

lights. The panel circuitry is divided into five functional circuits: the transducer selection circuit, heaters circuit, valve position circuit, all-systems calibrate circuit, and GSE interlock circuit. The panel is 19.76 inches wide, 16.76 inches deep, 10.47 inches high, and is secured to the front of the console by eight screws.

6-7. EVENT RECORDER.

6-8. Event recorder TR6260-S134 (figure 6-5) is an electrically operated instrument capable of recording 60 separate channels received as electrical signals from engine components. Fifty-nine of the 60 channels are actuated from separate signals transmitted from the engine components during an engine sequence test; the

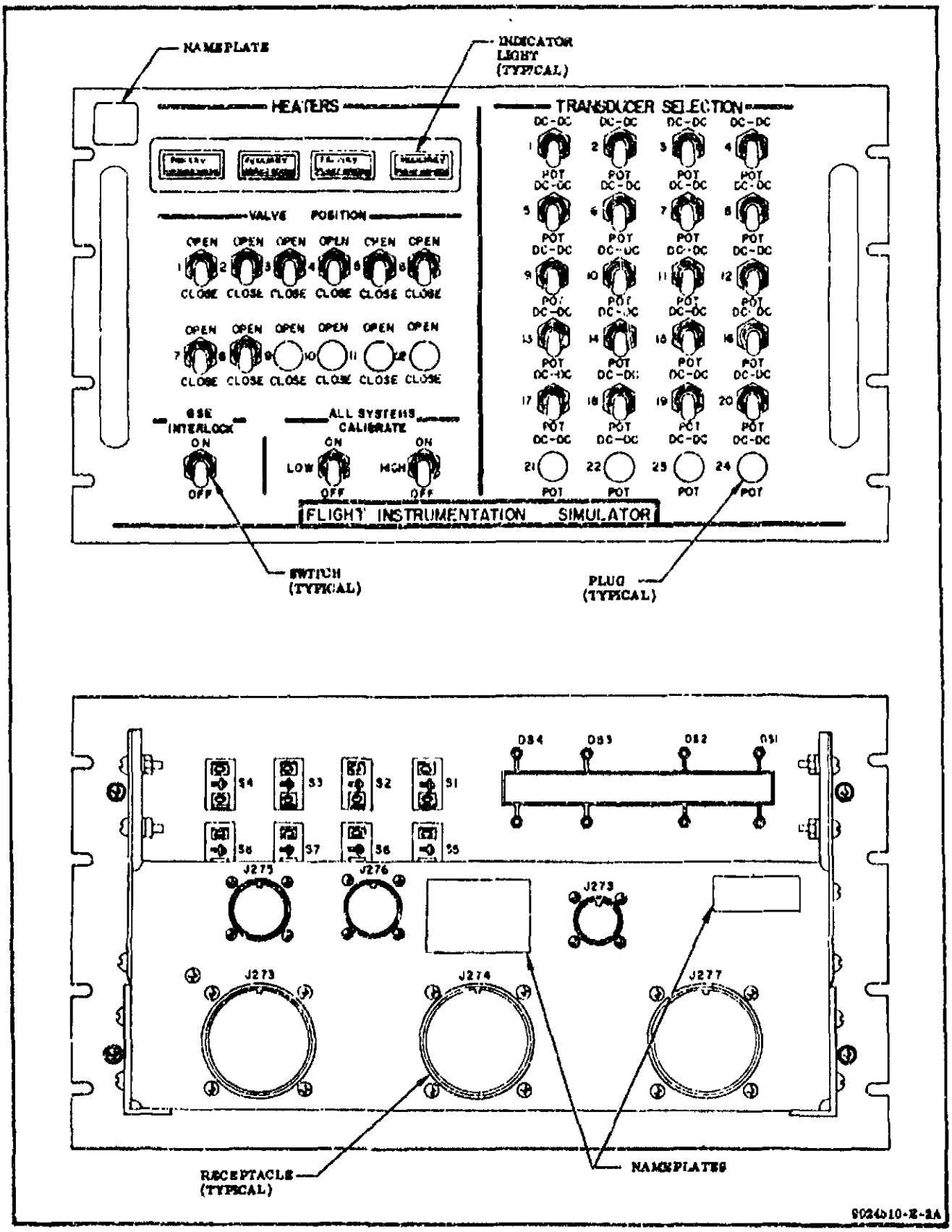


Figure 6-4. Flight Instrumentation Simulator Panel

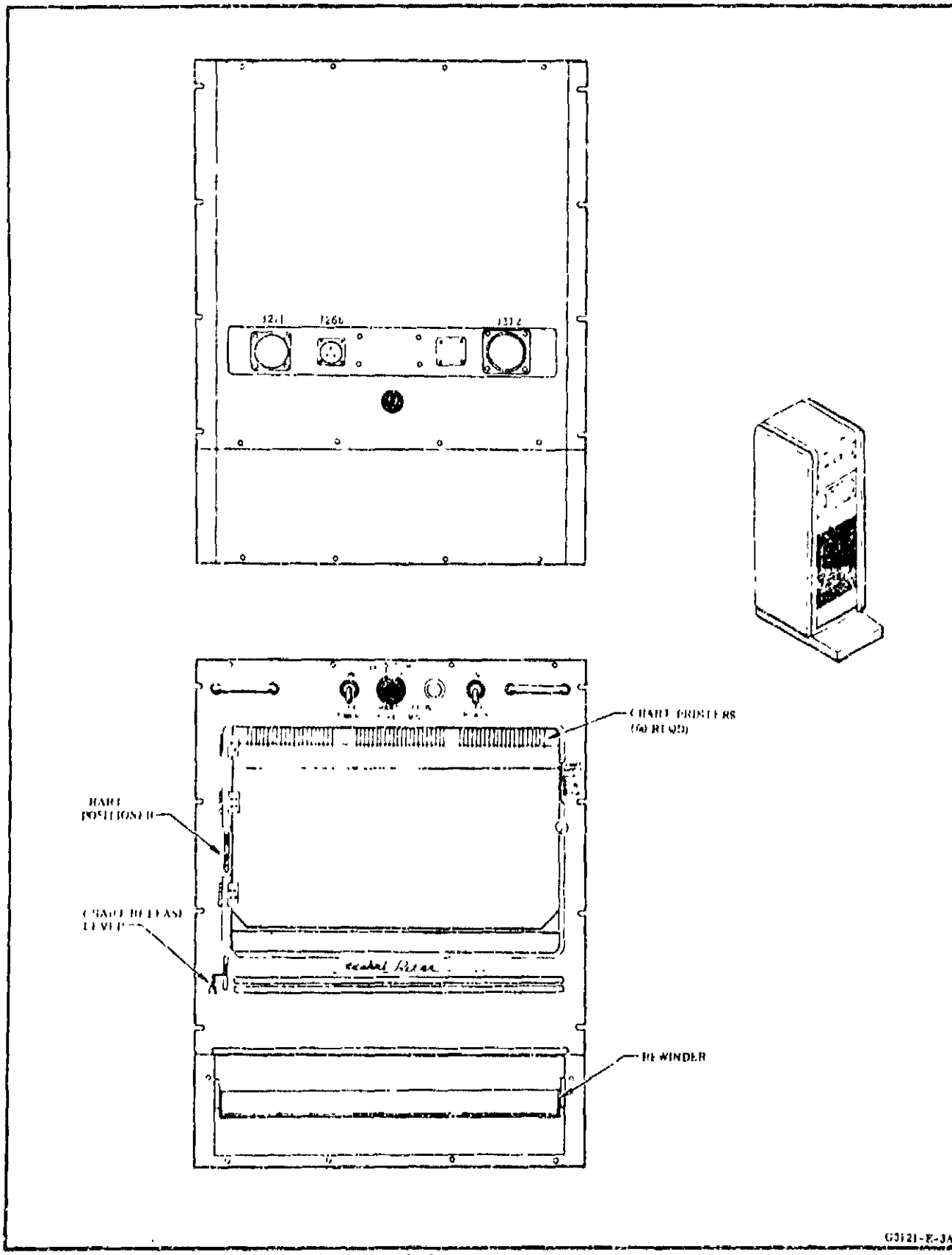


Figure 6-5. Event Recorder

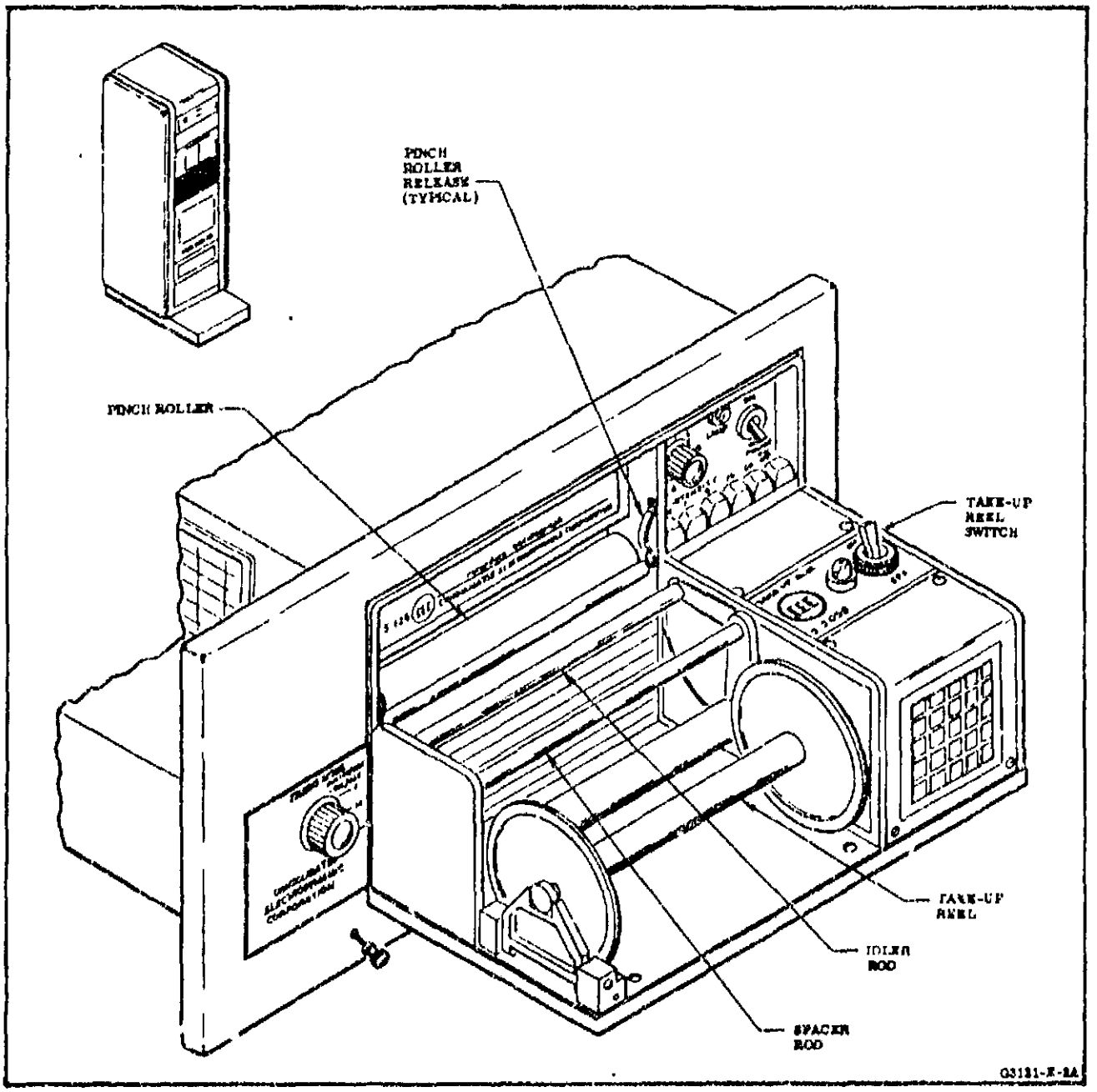


Figure 6-6. Recording Oscillograph

other channel is actuated by a one-second timer contained within the unit. During operation the signals are timed and graphically recorded by displacing a heated, knife-edged stylus on specially coated, heat-sensitive, chart paper. The chart paper passes between the styli and the edge of the writing table, then threads through the main drive rolls and to the rewinder spool. Before operation or after a new roll of chart paper is installed, the chart paper is adjusted to aline the traces on the paper with the styli, by using the chart positioner located on the left-hand side of the event recorder. The rewinder and friction drive mechanism, operated by a 115-vac motor, draw and maintain proper tension on the chart paper to ensure smooth operation.

6-9. RECORDING OSCILLOGRAPH.

6-10. Recording oscillograph 9025500 (figure 6-6) is capable of recording permanently on paper, eighteen separate, low-voltage, electrical impulses transmitted from the engine static and dynamic transducers during an engine sequence test. Information regarding operation and maintenance is in Operation and Maintenance Manual 5-124 (Consolidated Electrodynamics Corp) supplied with the data recorder console.

6-11. ACCESSORIES.

6-12. The external cables listed in figure 6-7 are stored in the data recorder console. If adequate storage space is not available in the data recorder console, the cables may be stored in the flight instrumentation checkout console.

Cable Type Number	Part Number	Use
NA5-27093TP216	19-9019903	Engine Checkout
NA5-27093TP233	19-9019904	Self-Checkout
NA5-27093TP234	19-9019905	Self-Checkout
NA5-27093TP235	19-9019906	Self-Checkout
NA5-27093TP236	19-9019907	Self-Checkout
NA5-27093TP237	19-9019908	Self-Checkout

Figure 6-7. Data Recorder Console Accessories

6-13. THEORY OF OPERATION.

6-14. The flight instrumentation simulator panel on the data recorder console performs a circuit continuity-test of the flight instrumentation checkout console. The two consoles are interconnected with the electrical cables provided. The desired test is selected on the flight instrumentation console calibration control panel and transmitted as a low-voltage signal to the flight instrumentation simulator panel circuit. The applicable switch is actuated, reducing the signal to a predetermined voltage and transmitting it back through the flight instrumentation console signal conditioner. The signal is conditioned to a recordable level, recorded on the data printer, and displayed on the digital voltohmmeter. The event recorder and recording oscillograph receive and record the signal.

6-15. Facility power is supplied by the power distribution panel to the event recorder and recording oscillograph. During an engine sequence test, the oscillograph and event recorder are connected between the electrical checkout and flight instrumentation checkout consoles. A sequence or components test is selected by actuating the applicable switch on the electrical checkout console panel. A signal is transmitted to the engine components then to the signal conditioner panel, where it is conditioned to a recordable level. The event recorder and recording oscillograph receive and record the signal.

6-16. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

6-17. The modifications incorporated changing the configuration of the data recorder console are listed in figure 6-8.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-131	1	14 May 1964
J2-144	2	14 May 1964
J2-214	4, 5	21 May 1965
J2-228	3	14 May 1964
J2-266	4, 7	26 January 1965
J2-275	4, 8	21 May 1965
J2-292	4, 6	2 November 1964

Figure 6-8. Configuration Changes--Manual Effectivity

6-18. To maintain compatability with the J-2 rocket engine, the data recorder console is modified as required. To record and provide a means of ready identification of these modifications, the part number of the affected panel is changed and the configuration of the changed console is identified by a MD number. (For an explanation of the MD numbering system, refer to Configuration Identification in the Introduction.) To determine the part number of a panel required for a given console configuration, see figure 6-9.

	Flight Instrumentation Simulator Panel	Power Distribution Panel	Event Recorder Panel	Oscillograph Panel
MD8	9025108-21	9025088	TR6260-S134	9025500
MD4	9024510-11	9025088	TR6260-S134	9025500

Figure 6-9. Data Recorder Console Panel Configurations

6-19. MAINTENANCE REQUIREMENTS FOR DATA RECORDER CONSOLE.

6-20. Maintenance tasks required on the data recorder console are listed in figure 6-10. Information presented lists the tasks to be performed, when the tasks shall be performed, and reference to data necessary to accomplish these tasks.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect console for completeness.	X	X			Refer to paragraph 6-11 for console accessories.
Inspect electrical cables and internal wire harnesses for:	X	X			Replace cable or harness. See figures 6-16 and 6-17.
Broken or frayed insulation.					
Damaged connectors.					
Paint console panels.				X	When damaged, paint surfaces with gray enamel (Federal Specification TT-E-529); color 26440 (Federal Standard 595).
Paint cabinet.				X	When damaged, paint surfaces with air-dry enamel, dark gray ADG, (Strantron).

Figure 6-10. Maintenance Requirements for Data Recorder Console (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Install protective caps on external electrical connectors and receptacles.				X	Whenever connector or receptacle is not in use.
Function-test console.				X	Every 6 months. Refer to paragraph 6-21 and perform abbreviated test if console has not been repaired, modified, or moved. Function-test completely every 2 years minimum or after repairing, modifying, or moving console.
Check continuity of external cables.				X	Every 6 months. See figure 6-17.
Calibrate console instrument.				X	Every 6 months. Refer to paragraph 6-23.
Clean console interior and exterior surfaces and external electrical cables.				X	As required to maintain cleanness. Refer to cleaning in section I.
Clean electrical panels.				X	As required to maintain cleanness of electrical circuitry. Frequency of cleaning depends on environment in which console is used. Refer to paragraph 6-39.
Lubricate event recorder.				X	Every 180 days. Refer to paragraph 6-37.
Lubricate event recorder motor drives.				X	Every 12 months. Refer to paragraph 6-37.
Prepare console for storage.				X	Whenever console is not in use. Refer to paragraph 6-25.
Check event recorder for supply of chart paper.		X			Load and position chart paper. Refer to paragraphs 6-31 and 6-33.
Check recording oscillograph for supply of recording paper.		X			Reload oscillograph when less than 15 percent full. Refer to paragraph 6-35.

Figure 6-10. Maintenance Requirements for Data Recorder Console (Sheet 2 of 2)

6-21. FUNCTION-TESTING.

6-22. Function-testing the console must be performed at an ambient temperature of 75 ±15° F, in the order specified. If results occur other than specified, the test must be terminated and the defective part repaired or replaced. The function-test procedures in figure 6-11 include a complete test and an abbreviated test. A complete test is accomplished by performing all steps in the procedure. An abbreviated test is accomplished by omitting steps preceded by an asterisk. Personnel must take the necessary safety precautions for electrical equipment during function-testing. As an aid in troubleshooting, see figures 6-12 and 6-14 through 6-17.

Step	Loc	Operation	Loc	Result

NOTE: The following abbreviations are used in this figure:

ER	Event Recorder
IF	Interface Panel
Loc	Location
PD	Power Distribution Panel
RO	Recording Oscillograph
S	Flight Instrumentation Simulator Panel
TE	Test Equipment
pos	Positive
neg	Negative

• Delete steps preceded by an asterisk (*) when performing an abbreviated function-test. See figure 6-10 for requirements for performing complete or abbreviated function-tests.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 1 of 20)

Step	Loc	Operation	Loc	Result
1		Obtain the following test equipment: a. Multimeter, Model 630-A (Triplett), or equivalent. b. Frequency Counter, Model 523CR (Hewlett Packard), or equivalent. c. DC Voltmeter, 0.05-percent accuracy, Model 803 (John Fluke Co), or equivalent. d. Short-circuit-proof, 28-vdc adjustable power supply capable of providing 5 amperes. e. Oscillator, Model 200CD (Hewlett Packard), or equivalent, capable of providing 0-11 vac at 60 cycles per second. f. Chart paper, E-60 m (Technirite Electronics Inc). g. Recording paper 217001 (Consolidated Electrodynamics Corp).		
2	IF	Apply 6.97 to 7.03 vdc between J258-j and k (neg).		No visible results.
3	S	Move TRANSDUCER SELECTION switches 1 through 20 to DC-DC.		No visible results.
4	S	Ensure that VALVE POSITION switches are in CLOSE position and GSE INTERLOCK and ALL SYSTEMS CALIBRATE switches are in OFF position.		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 2 of 20)

Step	Loc	Operation	Loc	Result
5	RO ER	Ensure that all switches are in OFF position.		
6	IF	Measure voltage between J258-n (neg) and the following J258 pins (pos): a. BB b. BM c. BJ d. BS e. BR f. BE g. AT h. AP i. AF j. AN k. AE l. u m. x	TE	0.14 to 0.30 vdc.
NOTE:		Do not disconnect leads from J258-j and k.		
7	IF	Apply 6.97 to 7.03 vdc (pos) to pin of receptacle J258 in column 1, and measure voltage between J258-n (neg) and pin (pos) of receptacle J258 in column 2.	TE	0.39 to 0.69 vdc.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 3 of 20)

Step	Loc	Operation	Loc	Result
7		(continued) Column 1 Column 2 a. BK BB b. BC BM c. BA BJ d. BU BS e. BF BR f. BN BE g. AU AT h. AC AP i. AH AF j. AA AN k. AR AE l. y u m. y x		
8	IF	Apply 6.97 to 7.03 vdc (pos) to pin of receptacle J258 in column 1, and measure voltage between J258-n (neg) and pin (pos) of receptacle J258 in column 2. Column 1 Column 2 a. BL BB b. BD BM c. AZ BJ	TE	0.76 to 1.08 vdc.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 4 of 20)

Step	Loc	Operation	Loc	Result
8		(continued) Column 1 Column 2 d. BT BS e. BH BR f. BP BE g. AV AT h. AD AP i. AJ AF j. AB AN k. AS AE l. w u m. z x		
9	S	Move ALL SYSTEMS CALIBRATE LOW switch to ON and measure voltage at J278-G (pos).	TE	6.97 to 7.03 vdc.
10	S	Move ALL SYSTEMS CALIBRATE HIGH switch to ON and measure voltage at J278-I.	TE	6.97 to 7.03 vdc.
11	S	Move ALL SYSTEMS CALIBRATE LOW and ALL SYSTEMS CALIBRATE HIGH switches to OFF.		No visible results.
CAUTION:		Connecting or disconnecting test leads without turning off power supply can cause arcing resulting in damage to equipment.		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 5 of 20)

Step	Loc	Operation	Loc	Result
12	IF TE	Disconnect power from J258-j and k and apply 6.97 to 7.03 vdc to J258-a and f (neg).		No visible results.
13	IF	Measure voltage between J258-f (neg) and J258-AW.	TE	0.14 to 0.30 vdc.
NOTE:		Do not disconnect leads from J258-a and f.		
14	IF	Apply 6.97 to 7.03 vdc (pos) to J258-AX and measure voltage at J258-AW (pos).	TE	0.39 to 0.69 vdc.
15	IF	Apply 6.97 to 7.03 vdc (pos) to J258-AY and measure voltage at J258-AW (pos).	TE	0.76 to 1.08 vdc.
16	IF	Disconnect power from J258-a and f and apply 6.97 to 7.03 vdc to J257-t and u (neg).		No visible results.
17	IF	Measure voltage between J257-u (neg) and following J257 pins (pos): a. AK b. AU c. AP d. AR e. AF f. s	TE	0.14 to 0.30 vdc.
NOTE:		Do not disconnect leads from J257-t and u.		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 6 of 20)

Step	Loc	Operation	Loc	Result
18	IF	Apply 6.97 to 7.03 vdc (pos) to pin of receptacle J257 in column 1, and measure voltage between J257-u (neg) and pin (pos) of receptacle J257 in column 2. Column 1 — Column 2 a. AL — AK b. AV — AU c. BA — AP d. AS — AR e. AH — AF f. q — s	TE	0.39 to 0 69 vdc.
19	IF	Apply 6.97 to 7.03 vdc to pin of receptacle J257 in column 1, and measure voltage between pin J257-u (neg) and pin (pos) of receptacle J257 in column 2. Column 1 — Colun.n 2 a. AM — AK b. AW — AU c. AZ — AP d. AT — AR e. AJ — AF f. r — s	TE	0.76 to 1.08 vdc.
20	IF TE	Disconnect power from J257-t and u and apply 6.79 to 7.03 vdc to J257-m and n (neg).		No visible results.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 7 of 20)

Step	Loc	Operation	Loc	Result
21	IF	Measure voltage between J257-n (neg) and J257-AN (pos).	TE	0.14 to 0.30 vdc
NOTE:		Do not disconnect leads from J257-m and n.		
22	IF	Apply 6.97 to 7.03 vdc (pos) to J257-AX and measure voltage between J257-n (neg) and AN (pos).	TE	0.39 to 0.69 vdc.
23	IF	Apply 6.97 to 7.03 vdc (pos) to J257-AY and measure voltage between J257-n (neg) and AN (pos).	TE	0.76 to 1.08 vdc.
24	IF	Disconnect power from J257-m and n and apply 27.5 to 28.5 vdc to J258-m and n (neg).		No visible results.
25	S	Move TRANSDUCER SELECTION switches 1 through 20 to POT.		No visible results.
26	IF	Measure voltage between J258-k (neg) and the following J258 pins: a. BB b. BM c. BJ d. BS e. BR f. BE g. AT h. AP i. AF j. AN k. AE l. u m. x	TE	13-15 vdc.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 8 of 20)

Step	Loc	Operation	Loc	Result
27	IF	Disconnect power from J258-m and n and apply 27.5 to 28.5 vdc to J258-d and b (neg).		No visible results.
28	IF	Measure voltage between J258-b (neg) and J258-AW.	TE	13-15 vdc.
29	IF	Disconnect power from J258-d and b and apply 27.5 to 28.5 vdc to J257-v and u (neg).		No visible results.
30	IF	Measure voltage between J257-u (neg) and the following pins of receptacle J257: a. AK b. AU c. AP d. AR	TE	13-15 vdc.
31	IF	Disconnect power from J257-u (neg) and apply 27.5 to 28.5 vdc to J257-w (neg).		No visible results.
32	IF	Measure voltage between J257-w (neg) and AF.	TE	13-15 vdc.
33	IF	Disconnect power from J257-v and w and apply 27.5 to 28.5 vdc to J257-i and j (neg).		No visible results.
34		Measure voltage between J257-j (neg) and AN.		13-15 vdc.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 9 of 20)

Step	Loc	Operation	Loc	Result
NOTE:		The results of step 35 remain on only while the power supply leads are connected.		
35	IF	Disconnect power from J257-i and j and sequentially apply 27.5 to 28.5 vdc to the following pins:		
		a. J258-g and p (neg)	S	AUXILIARY GROUND HEATER light on.
		b. J258-r and s (neg)	S	AUXILIARY FLIGHT HEATER light on.
		c. J257-x and y (neg)	S	PRIMARY GROUND HEATER light on.
		d. J257-z and AA (neg)	S	PRIMARY FLIGHT HEATER light on.
*36	IF	Check continuity between the following pins:	TE	Less than one ohm.
		a. J279-AH and AJ		
		b. J279-j and k		
		c. J279-p and n		
		d. J279-r and s		
		e. J279-t and u		
		f. J279-w and x		
		g. J279-z and AA		
		h. J279-AL and AM		
		i. J279-AP and AR		
		j. J279-AT and AU		
		k. J279-AW and AX		
		l. J279-AZ and BA		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 10 of 20)

Step	Loc	Operation	Loc	Result
*36		(continued)		
		m. J279-BC and BD		
		n. J279-BF and BH		
		o. J279-BJ and BK		
		p. J279-BM and BN		
		q. J279-BS and BT		
		r. J279-N and P		
		s. J279-S and T		
		t. J279-V and W		
		u. J279-AD and AE		
		v. J257-AE and AD		
		x. J258-AK and AL		
		y. J260-F and G		
		z. J260-M and S		
37	IF	Measure resistance between the following pins:	TE	
		a. J279-AJ and AK		459-651 ohms.
		b. J279-k and j		27-33 ohms.
		c. J279-n and m		27-33 ohms.
		d. J279-s and q		351-429 ohms.
		e. J279-u and y		351-429 ohms.
		f. J279-x and y		351-429 ohms.
		g. J279-AA and AB		74-90 ohms.
		h. J279-AM and AN		612-748 ohms.
		i. J279-AR and AS		612-748 ohms.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 11 of 20)

Step	Loc	Operation	Loc	Result
37		(continued)		
		j. J279-AU and AV		612-748 ohms.
		k. J279-AX and AY		90-110 ohms.
		l. J279-BA and BB		99-121 ohms.
		m. J279-BD and BE		135-165 ohms.
		n. J279-BH and BR		351-429 ohms.
		o. J279-BK and BL		9-11 ohms.
		p. J279-BN and BP		738-902 ohms.
		q. J279-BT and BU		738-902 ohms.
		r. J279-P and R		351-429 ohms.
		s. J279-T and U		9-11 ohms.
		t. J279-W and g		738-902 ohms.
		u. J279-AE and AF		459-561 ohms.
		v. J257-AD and AC		144-176 ohms.
		w. J258-AL and AM		144-176 ohms.
		x. J260-G and H		144-176 ohms.
		y. J260-L and M		144-176 ohms.
38	IF	Apply 27.5 to 28.5 vdc to J258-m and n (neg).		No visible results.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 12 of 20)

Step	Loc	Operation	Loc	Result
39	IF	Measure voltage between J258-k (neg) and the following J257 pins: a. BU b. BL c. BP d. BB e. BR f. BD	TE	13-15 vdc
40	IF	Disconnect power supply from J258-m and n.		
41	S	Move VALVE POSITION switches 5 through 8 to OPEN.		No visible results.
42	IF	Measure resistance between J257-AB and the following J257 pins: a. BS b. BJ c. BM d. BF	TE	Zero ±1 ohm.
43	S	Move VALVE POSITION switches 1 through 4 to OPEN.		No visible results.
44	IF	Repeat step 42.	TE	Greater than one megohm.
45	IF	Measure resistance between J257-AB and the following J257 pins: a. BT b. BK	TE	Zero ±1 ohm.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 13 of 20)

Step	Loc	Operation	Loc	Result
45		(continued)		
		c. BN		
		d. BH		
		e. BC		
		f. BE		
		g. R		
		h. Y		
46	S	Move VALVE POSITION switches 1 through 8 to CLOSED and repeat step 45.	TE	Greater than one megohm.
47	IF	Measure resistance between the following J259 pins:		
		a. A and B b. E and F c. J and K d. R and S	TE	108-132 ohms.
		e. C and D f. G and H g. N and P h. T and U	TE	210 to 1,010 ohms.
		i. A and D j. B and C k. E and H l. F and G m. J and P n. K and N o. R and U p. S and T	TE	2,340 to 2,860 ohms.
48	PD	Pull out circuit breaker.		No visible results.
*49	IF	Measure resistance between J252-B and C.	TE	Greater than 50K ohms.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 14 of 20)

Step	Loc	Operation	Loc	Result
*50	IF	Measure resistance between J252-C and console cabinet. Ensure that test probe has good bond to cabinet.	TE	Less than one ohm.
51	IF	Connect facility power cable to console at receptacle J252. (See figure 6-2 for cable requirements.)		No visible results.
52	RO ER	Ensure that POWER switches and TAKE UP REEL switch are in OFF position.		No visible results.
53		Energize facility power.		No visible results.
54	PD	Depress circuit breaker.	PD	115 VAC POWER ON light on. VOLTS meter indicates 105-125 vac.
55	ER	Check CHART SUPPLY and ensure that recorder is loaded with properly positioned chart paper. (Refer to paragraphs 6-31 and 6-33.)		
56	ER	Move POWER switch to ON.	ER	Power light on.
57	ER	Rotate CHART SPEEDS switch to each of the following:	ER	Chart paper moves at the following speeds:
		a. .05		0.05 inch per minute.
		b. 5		5 inches per minute.
		c. 125		125 inches per minute.
58	ER	Rotate CHART SPEEDS switch to 5 and move TIMER switch to ON.	ER	Timing pips for pen 60 are 2 small divisions apart.
59	ER	Rotate CHART SPEEDS switch and move TIMER switch to OFF.	ER	Chart paper stops. Pen 60 returns to original position.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 15 of 20)

Step	Loc	Operation	Loc	Result
60	IF	Connect negative lead of power supply to J254-B and positive lead to receptacle pins associated with pens 1 through 20. See figure 6-12 for receptacle, pin, and pen identification.		

NOTE: It may be necessary to connect 20 wires to a common bus, then connect each wire to the pin of the receptacle for each pen. The common bus can then be connected to the power supply lead.

61		(Deleted)		
62	ER	Rotate CHART SPEEDS switch to 5.	ER	Chart paper moves 5 inches per minute.
63	TE	Apply 27.5 to 28.5 vdc.	ER	Pens 1 through 20 deflect 1/8 ± 1/16 inch to the left (when facing event recorder).
64	TE	Momentarily disconnect each of the 20 test leads.	ER	Respective pen momentarily deflects.

CAUTION: Test leads are energized and may arc when momentarily disconnected. Use extreme care since arcing can damage equipment.

65	TE	Remove 27.5 to 28.5 vdc.	ER	Pens deflect to right (original position) and remain.
66	ER	Move POWER switch to OFF.	ER	Chart stops. Power light off.
67		Disconnect test leads from receptacle pins and repeat steps 60, 61, and 63 through 66 for pens 21 through 40, then for pens 44 through 55.	ER	Same as steps 61 and 63 through 66.
68	IF	Disconnect test equipment.		
69	ER	Move POWER switch to ON.	ER	Chart moves. Power light on.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 16 of 20)

Step	Loc	Operation	Loc	Result
70	IF	Momentarily apply 27.5 to 28.5 vdc between J255-17 and 56 (neg).	ER	Pen 1 momentarily deflects 1/8 inch to left.
71	ER	Move POWER switch to OFF and rotate CHART SPEEDS switch to OFF.	ER	Chart stops. Power light off.
72	PD	Pull out 115 VAC circuit breaker.	PD	115 VAC POWER ON light off. VOLTS meter indicates zero.
73	RO	Disconnect generator plug lead P492 from T-SYNC jack on timer package and connect plug to frequency counter.		
74	RO	Make sure TIMING MODE knob is in OFF/EXT position.		
75	TE	Energize frequency counter.		
76	PD	Depress 115 VAC circuit breaker.	PD	115 VAC POWER ON light on. VOLTS meter indicates 105-125 vdc.
			TE	Frequency counter indicates 99-101 cps.
NOTE:		Frequency rate is not adjustable. Replacement of generator is necessary if results of step 76 are not obtained.		
77	PD	Pull out 115 VAC circuit breaker.	PD	115 VAC POWER ON light off. VOLTS meter indicates zero.
78	TE RO	Disconnect generator plug lead P492 from frequency counter and reinstall lead in T-SYNC jack on timer package.		
79	PD	Depress 115 VAC circuit breaker.	PD	115 VAC POWER ON light on. VOLTS meter indicates 105-125 vdc.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 17 of 20)

Step	Loc	Operation	Loc	Result
NOTE:		To eliminate need to reload oscillograph, a 15-percent minimum of the total capacity of recording paper is recommended.		
80	RO	Move TAKE UP REEL switch to ON, then move POWER switch to ON.		
80A	RO	Depress and momentarily hold LAMP pushbutton. This is a mercury-vapor arc lamp, and it may be necessary to repeat the operation several times to strike the arc.	RO	Recorder galvanometer lamp on. On recording oscillographs incorporating a LAMP indicator light, the indicator light comes on.
81	RO	Momentarily depress red ON-OFF pushbutton. If erratic sound is heard, remove cover from TIMING MODE module and adjust potentiometer R107 (nearest back of TIMING MODULE) to obtain steady sound level from oscillograph.	RO	Drive motor operates smoothly. TAKE UP REEL light on.
82	RO	Depress pushbutton 16 and allow to record.	RO	Paper transports and traces recorded are at a readable density.
NOTE:		A lamp intensity adjustment may be necessary to obtain a readable trace. Refer to Operation and Maintenance Manual 5-124 (Consolidated Electrodynamics Corp).		
83	RO	Momentarily depress red ON-OFF pushbutton.	RO	Drive motor and recording paper stop. TAKE UP REEL light on.
84	RO	Measure space between timing lines and inspect for consistent printing of lines.	RO	0.144 to 0.176 inch between each line printed.
NOTE:		An acceptable method of obtaining this measurement is to measure a total of 25 spaces (distance between 26 lines). This distance shall be 3.6 to 4.4 inches.		
		o Inconsistent printing of timing lines or spacing indicates an out-of-synchronization condition. Adjust potentiometer R107 to correct this condition (step 81). Repeat steps 82 through 84.		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 18 of 20)

Step	Loc	Operation	Loc	Result
85	RO	Momentarily depress red ON-OFF pushbutton then depress the following pushbuttons:		Drive motor operates. TAKE UP REEL light on. Recording paper transports at the following speeds ±10%:
		a. .25		0.25 inch per second.
		b. 1		1 inch per second.
		c. 4		4 inches per second.
		d. 64		64 inches per second.
86	RO	Momentarily depress red ON-OFF pushbutton.		Drive motor and recording paper stop. TAKE UP REEL light on.
87	TE	Assemble test circuit using oscillator and multimeter. (See figure 6-13.)		
88	TE	Adjust oscillator to an output of 60 cps and 0.85 volts rms.		
89	RO	Momentarily depress red ON-OFF pushbutton.	RO	Drive motor operates. TAKE UP REEL light on.
90	RO	Depress pushbutton 4.	RO	Recording paper transports.
91	IF	Sequentially apply 0.85 volts between the following pins, allowing a sine wave to be recorded:	RO	Records channel amplitude of 0.75 to 1.25 inches.
		a. J255-57 and 8		
		b. J255-58 and 9		
		c. J255-59 and 10		
		d. J255-35 and 12		
		e. J254-P and H		
		f. J254-J and K		
		g. J254-L and M		
		h. J254-G and N		
		i. J254-Z and a		

Figure 6-11. Function-Testing Data Recorder Console (Sheet 19 of 20)

Step	Loc	Operation	Loc	Result
91		(continued)		
		j. J254-F and E		
		k. J254-S and R		
		l. J254-Y and X		
		m. J254-W and V		
		n. J254-T and U		
92	TE	Adjust oscillator output to 60 cps and 11 volts.		
		Sequentially apply 11.0 volts between the following pins, allowing a sine wave to be recorded:	RO	Records channel amplitude of 0.75 to 1.25 inches.
		a. J255-34 and 16		
		b. J255-48 and 13		
		c. J255-49 and 15		
		d. J255-50 and 11		
93	RO	Depress red ON-OFF push-button.	RO	Drive motor and recording paper stop. TAKE UP REEL light off.
94	RO	Move POWER and TAKE UP REEL switches to OFF.	RO	Recorder galvonometer lamp off. On recording oscillographs incorporating a LAMP indicator light, the indicator light goes off.
95		Measure amplitude deflection obtained in steps 91 and 92.		0.75 to 1.25 inches.
96		Measure the space between the traces of channels 1 through 13.		9/32 to 11/32 inch.
NOTE:		If spacings are not within tolerance, adjust as outlined in Operation and Maintenance Manual 5-124 (Consolidated Electrodynamics Corp), then repeat steps 88 through 95.		
97	PD	Pull out 115 VAC circuit breaker.	PD	115 VAC POWER ON light off. VOLTS meter indicates zero.

Figure 6-11. Function-Testing Data Recorder Console (Sheet 20 of 20)

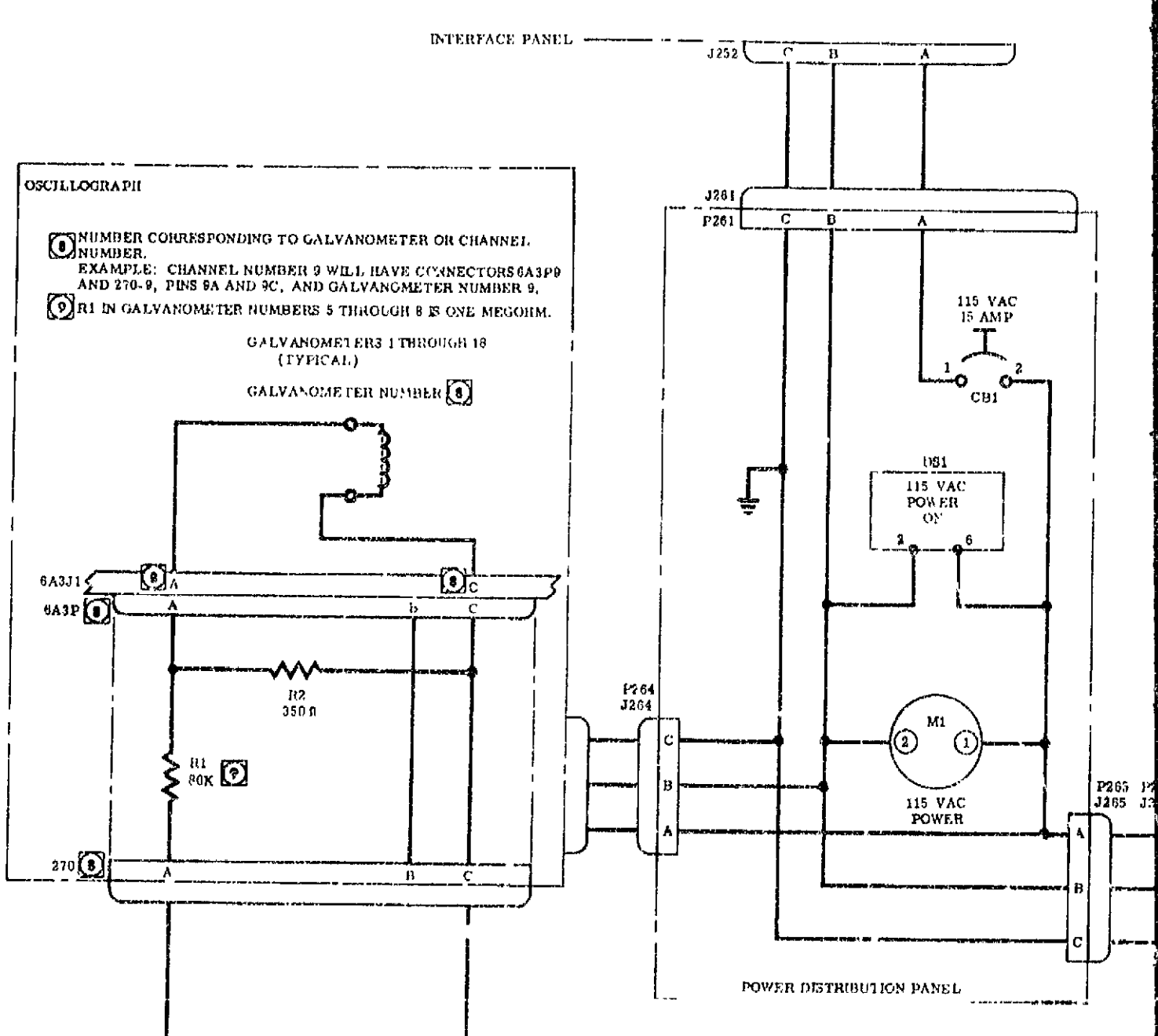
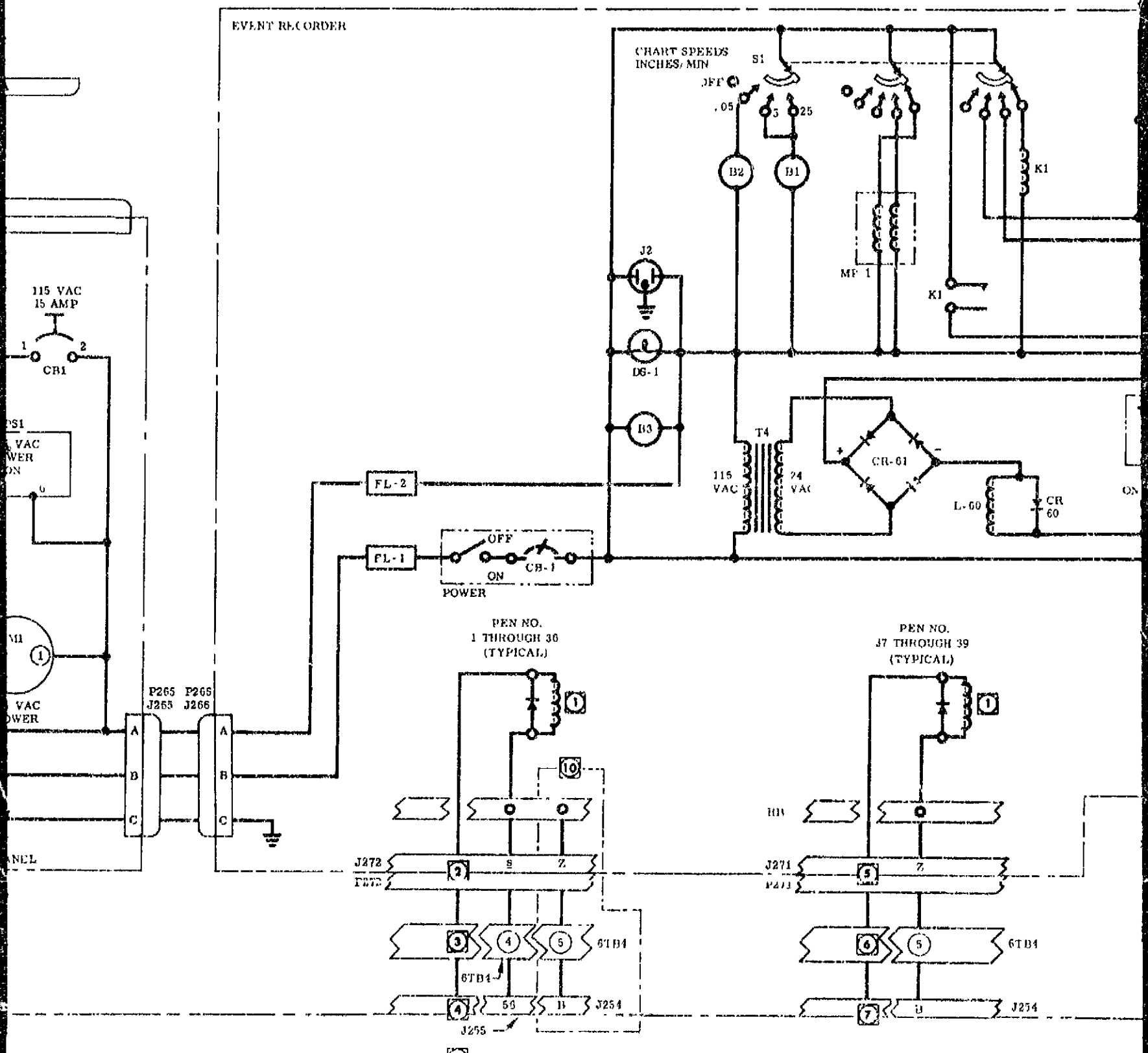
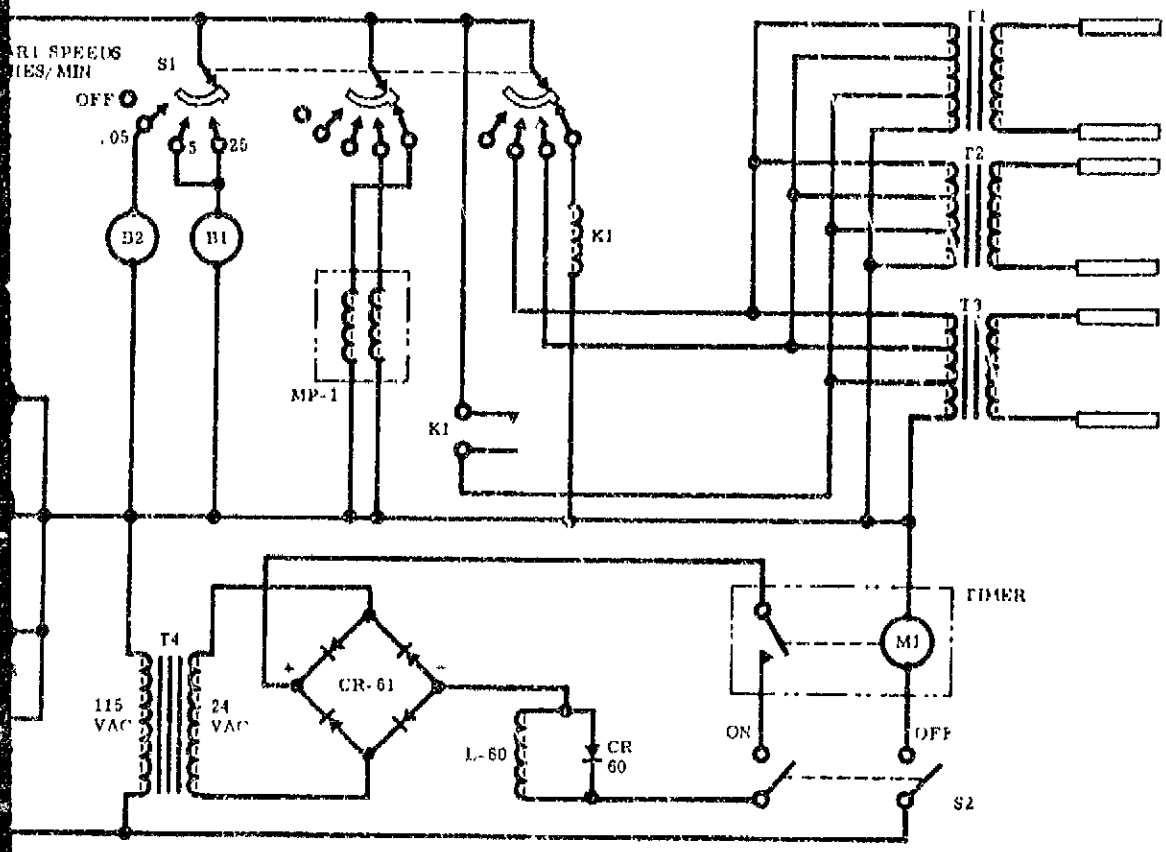
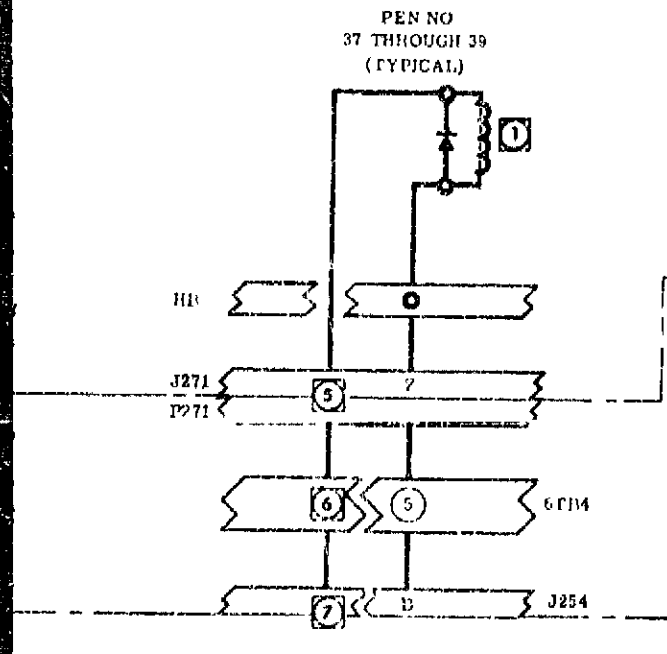


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 1 of 6)


EVENT RECORDER
CHART SPEEDS INCHES/ MIN
S1
OFF
.05
5
25
B2
B1
K1
MF 1
K1
J2
DG-1
B3
T4
115 VAC
24 VAC
CR-61
L-60
CR 60
115 VAC 15 AMP
CB1
FL-2
FL-1
OFF
ON
CB-1
POWER
P265 P266
J265 J266
A
B
C
PEN NO. 1 THROUGH 36 (TYPICAL)
PEN NO. 37 THROUGH 39 (TYPICAL)
J272
J271
6TB4
J254
J255
10 APPLICABLE TO PENS 34 AND 35.



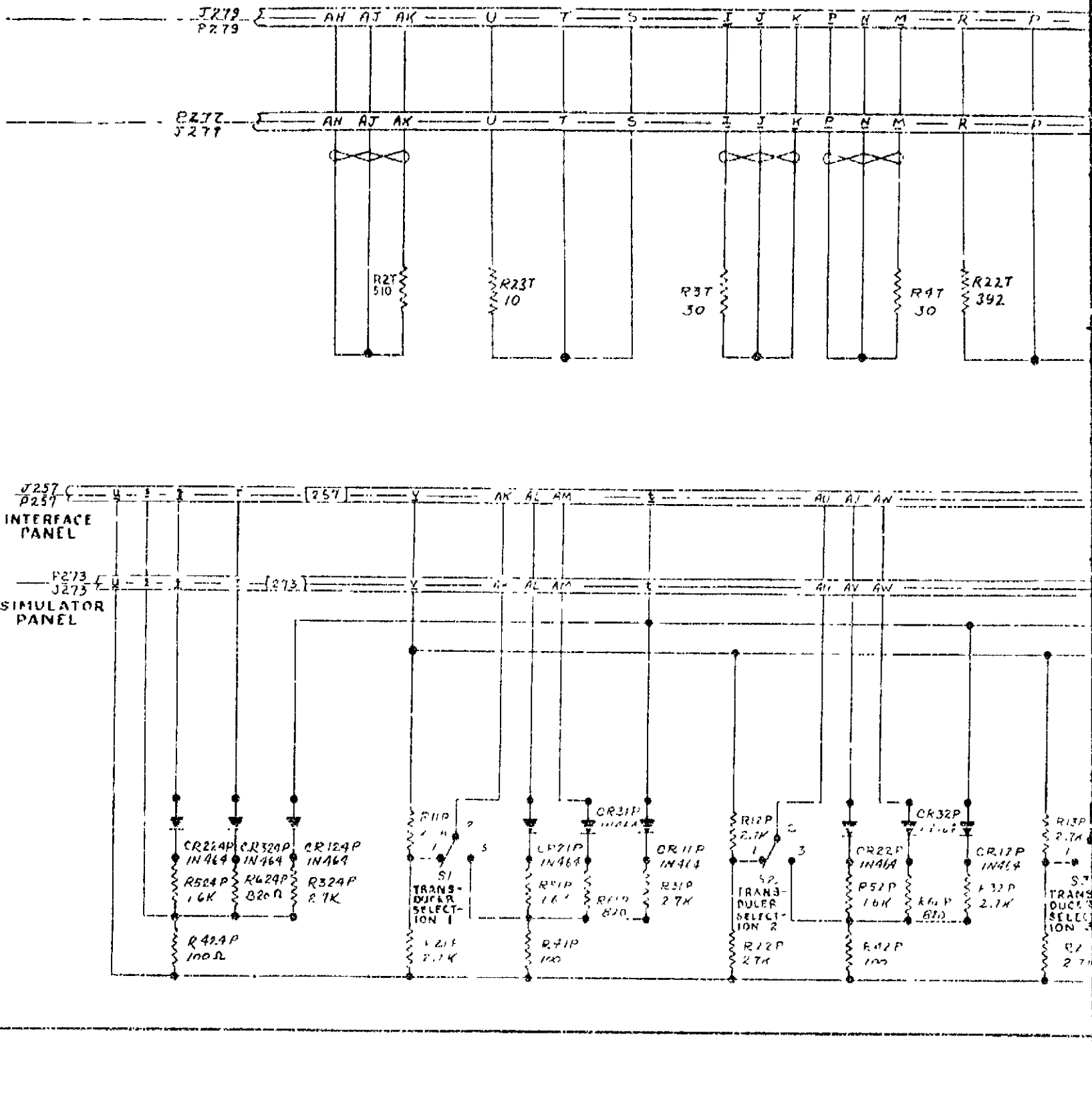


1	2	3	4
1	A	6TB1-1	J255-17
2	B	6TB1-2	J255-32
3	C	6TB1-3	J255-33
4	D	6TB1-4	J255-37
5	E	6TB1-5	J255-38
6	F	6TB1-6	J254-L
7	G	6TB1-7	J254-K
8	H	6TB1-8	J254-b
9	J	6TB1-9	J255-44
10	K	6TB1-10	J254-e
11	L	6TB1-11	J254-d
12	M	6TB1-12	J255-51
13	N	6TB1-13	J254-j
14	P	6TB1-14	J255-36
15	R	6TB4-15	J254-h
16	S	6TB1-16	J254-g
17	T	6TB2-16	J254-f
18	U	6TB2-15	J255-30
19	V	6TB2-14	J255-31
20	W	6TB2-13	J254-c
21	X	6TB2-12	J255-18
22	Z	6TB2-11	J255-19
23	a	6TB2-10	J255-39
24	b	6TB2-9	J255-40
25	c	6TB2-8	J255-41
26	d	6TB2-7	J255-42
27	e	6TB2-6	J255-46
28	f	6TB2-5	J255-45
29	g	6TB2-4	J255-47
30	h	6TB2-3	J255-52
31	j	6TB2-2	J255-43
32	k	6TB2-1	J255-20
33	m	6TB3-1	J255-26
34	n	6TB3-2	J254-C
35	p	6TB3-3	J254-D
36	r	6TB3-4	J255-55

1	3	6	7
37	A	6TB3-5	J255-26
38	B	6TB3-6	J255-27
39	C	6TB3-7	J255-53
40	D	6TB3-8	J255-54
41	E	6TB3-9	J254-A
42	F	6TB3-10	J254-C
43	G	6TB3-11	J254-D
42	F	6TB3-10	Spare
43	G	6TB3-11	Spare
44	H	6TB3-12	J255-21
45	J	6TB3-13	J255-22
46	K	6TB3-14	J255-23
47	L	6TB3-15	J255-24
48	M	6TB3-16	J255-7
49	N	6TB4-13	J255-6
50	P	6TB4-14	J255-5
51	Q	6TB4-15	J255-4
52	R	6TB4-13	J255-3
53	S	6TB4-12	J255-2
54	T	6TB4-11	J255-1
55	U	6TB4-10	J255-14
56	V	6TB4-9	———
57	W	6TB4-8	———
58	X	6TB4-7	———
59	Y	6TB4-6	———

LEGEND

B1	900 RPM DRIVE MOTOR
B2	1.8 RPM DRIVE MOTOR
B3	REWIND MOTOR
CB-1	10 AMPERE CIRCUIT BREAKER
CR-60	DIODE
CR-61	FULL-WAVE RECTIFIER
DS-1	PILOT LIGHT (AMBER)
F1-1, F1-2	LINE FILTER
J2	AUXILIARY ELECTRICAL RECEPTACLE (115 VAC)
K1	RELAY
L60	COIL
M1	ONE SECOND TIMER
MP-1	TRANSMISSION ASSEMBLY
T1, T2, T3	HEAT TRANSFORMER
T4	COIL TRANSFORMER


J279
P279
P277
J277
AH AJ AK U T S I J K P N M R P
R2T 510
R23T 10
R3T 30
R4T 30
R22T 392
J257
P257
INTERFACE PANEL
P273
J273
SIMULATOR PANEL
257
273
AK AL AM AU AV AW
CR22AP IN464
CR32AP IN464
CR12AP IN464
R52AP 1.6K
R42AP 820Ω
R32AP 2.7K
R42AP 100Ω
R11P
S1 TRANSDUCER SELECTION 1
R21P 2.7K
CR21P IN464
CR31P IN464
CR11P IN464
R41P 100
R31P 2.7K
R12P 2.7K
S2 TRANSDUCER SELECTION 2
R22P 2.7K
CR22P IN464
CR32P IN464
CR12P IN464
R52P 1.6K
R42P 820
R32P 2.7K
R42P 100
R13P 2.7K

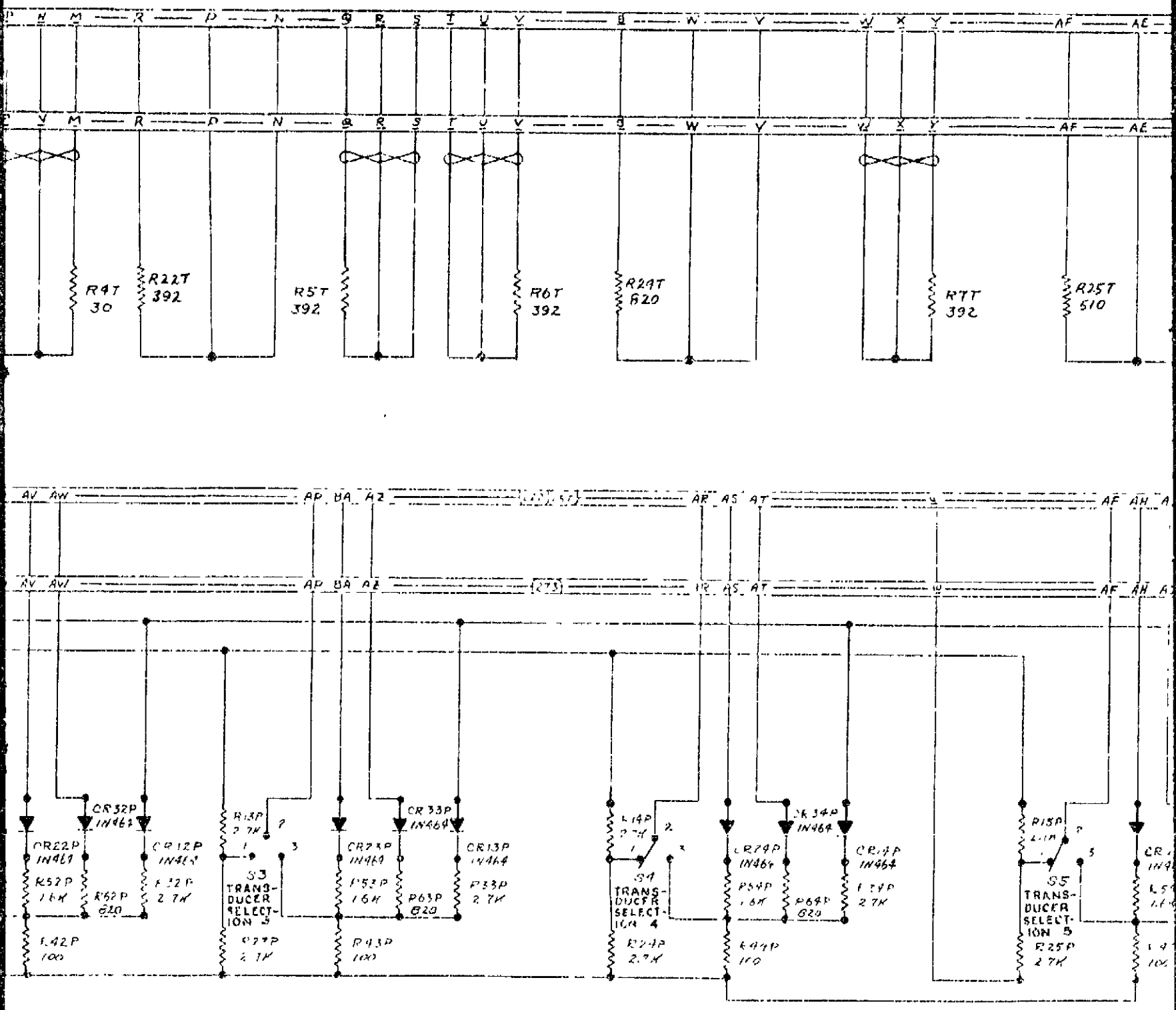


Figure 6-12. Dat

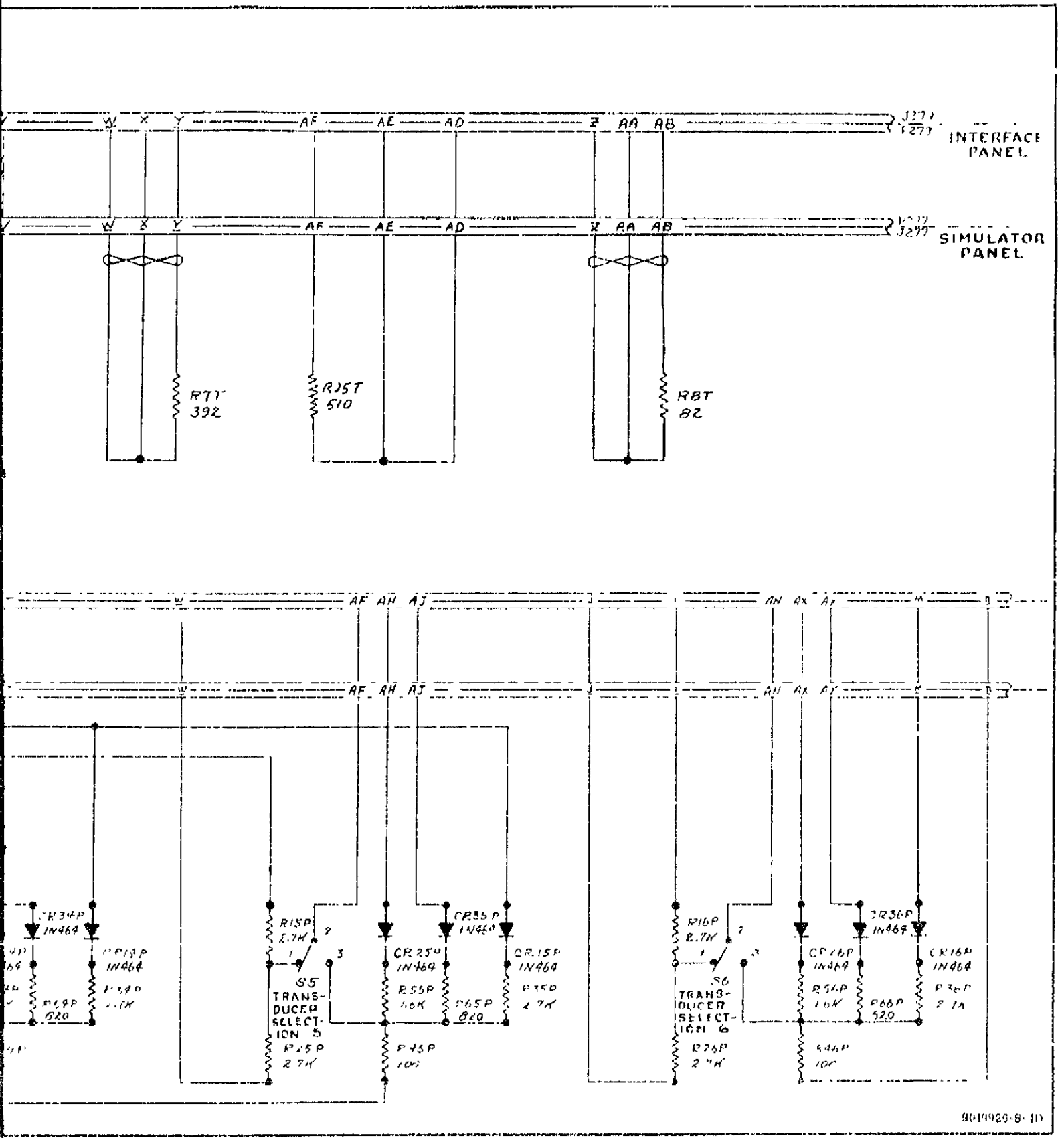


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 2 of 6)

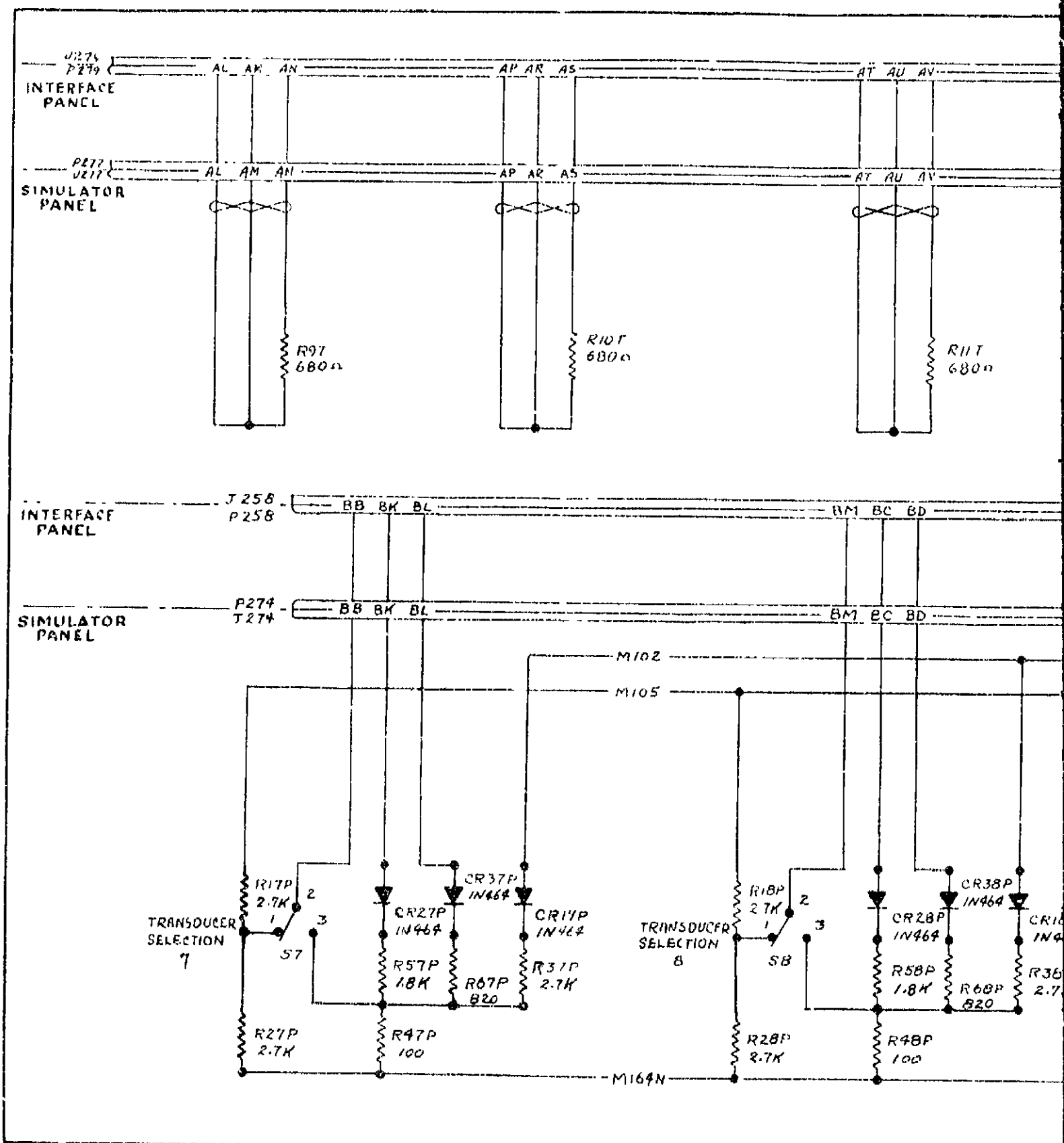
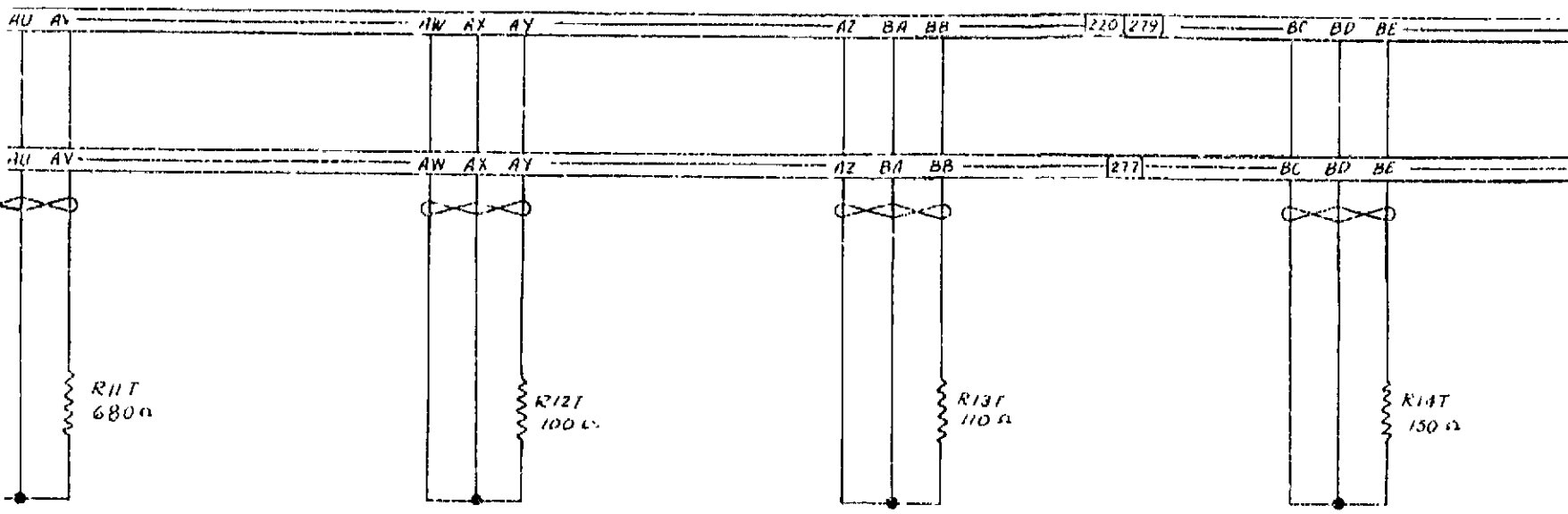
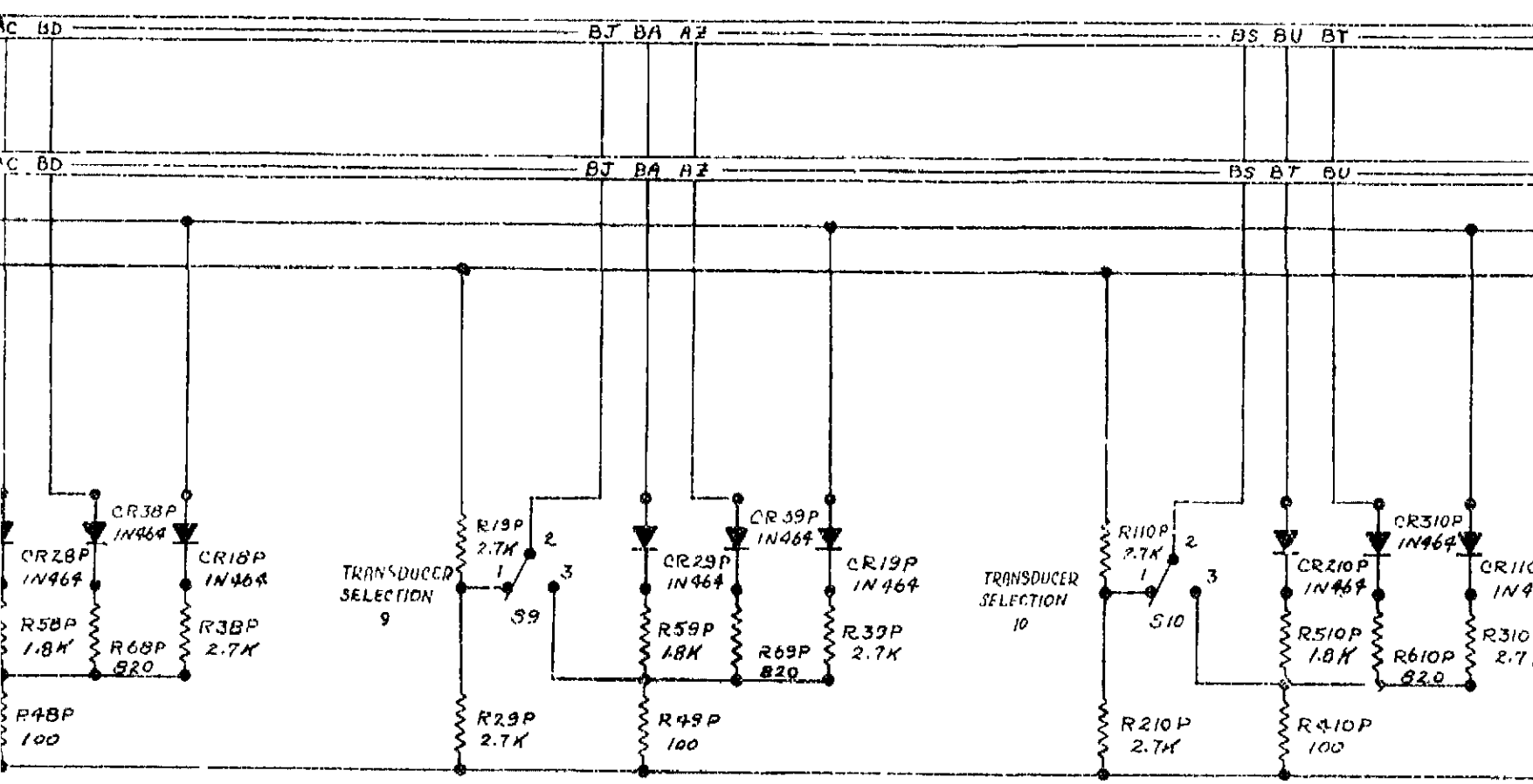
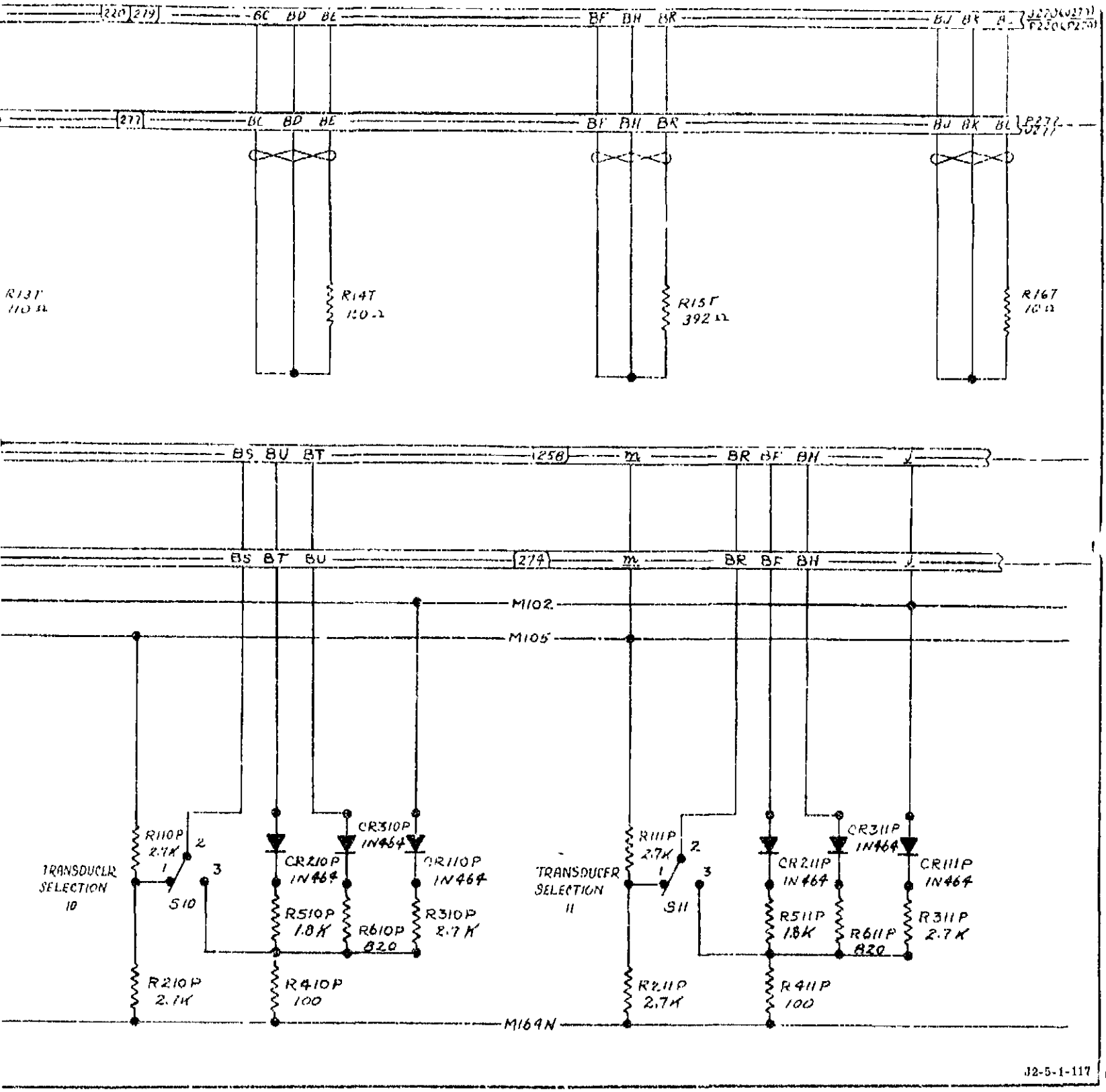
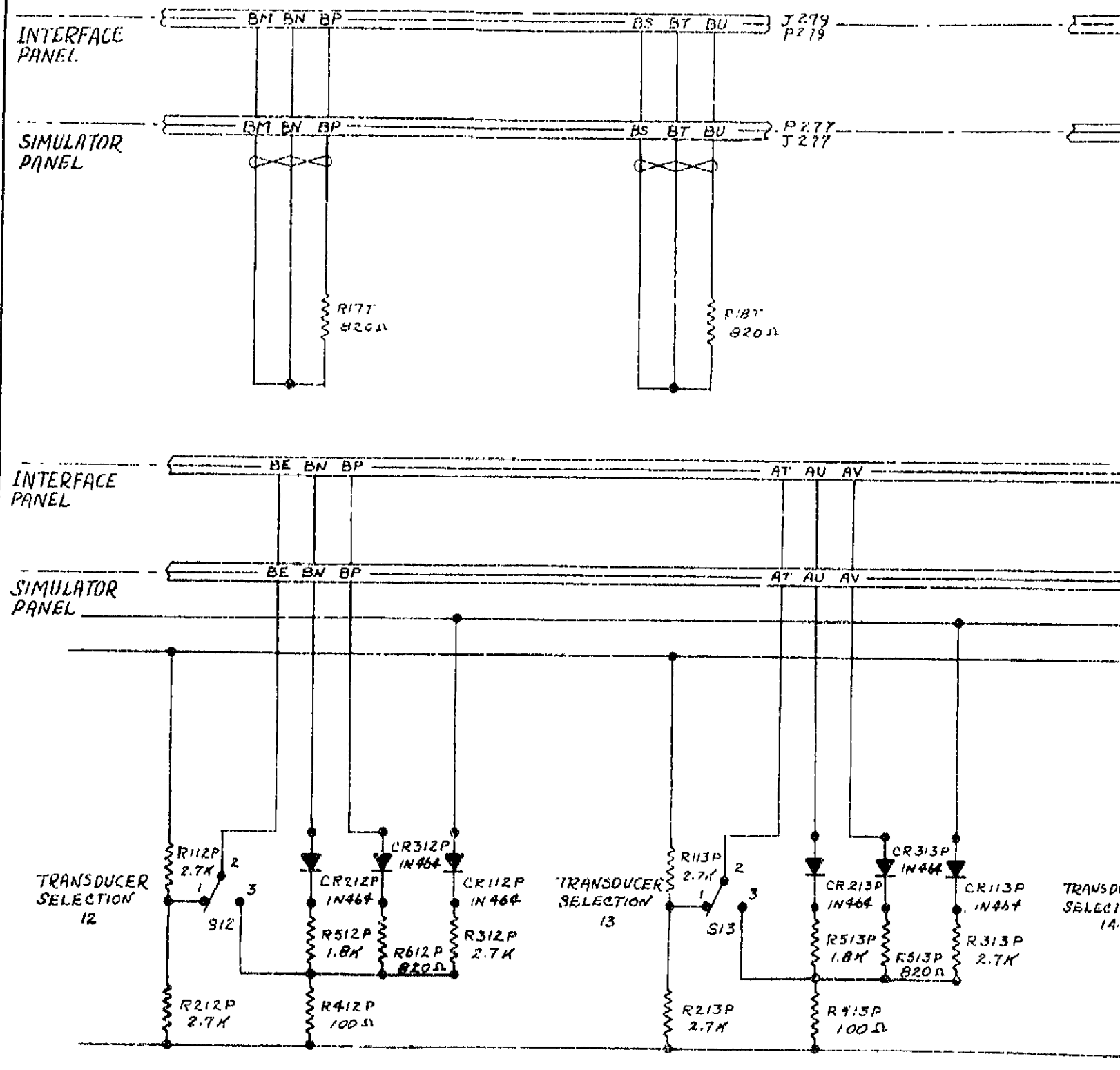


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 3 of 6)


AU AV
AW AX AY
AZ BA BB
220 279
BC BD BE
277
R11T 680Ω
R12T 100Ω
R13T 110Ω
R14T 150Ω


BJ BA AZ
BS BU BT
CR38P IN464
CR28P IN464
CR18P IN464
R58P 1.8K
R68P 820
R38P 2.7K
R48P 100
TRANSDUCER SELECTION 9
S9
R19P 2.7K
R29P 2.7K
CR29P IN464
CR39P IN464
CR19P IN464
R59P 1.8K
R69P 820
R39P 2.7K
R49P 100
TRANSDUCER SELECTION 10
S10
R110P 2.7K
R210P 2.7K
CR210P IN464
CR310P IN464
R510P 1.8K
R610P 820
R410P 100


BC BD BE
BF BH BR
BJ BK BL
R13T
110 Ω
R14T
100 Ω
R15T
392 Ω
R16T
10 Ω
BS BU BT
BR BF BH
M1102
M1105
M164N
R110P
2.7K
TRANSDUCER
SELECTION
10
S10
CR210P
IN464
CR310P
IN464
CR110P
IN464
R510P
1.8K
R610P
820
R310P
2.7K
R210P
2.7K
R410P
100
R111P
2.7K
TRANSDUCER
SELECTION
11
S11
CR211P
IN464
CR311P
IN464
CR111P
IN464
R511P
1.8K
R611P
820
R311P
2.7K
R211P
2.7K
R411P
100


INTERFACE PANEL
BM BN BP
BS BT BU
J279
P279
SIMULATOR PANEL
P277
J277
R17T
820Ω
R18T
820Ω
INTERFACE PANEL
BE BN BP
AT AU AV
SIMULATOR PANEL
TRANSDUCER SELECTION 12
R112P 2.7K
S12
CR312P IN464
CR212P IN464
CR112P IN464
R512P 1.8K
R612P 820Ω
R312P 2.7K
R212P 2.7K
R412P 100Ω
TRANSDUCER SELECTION 13
R113P 2.7K
S13
CR213P IN464
CR313P IN464
CR113P IN464
R513P 1.8K
R613P 820Ω
R313P 2.7K
R213P 2.7K
R413P 100Ω

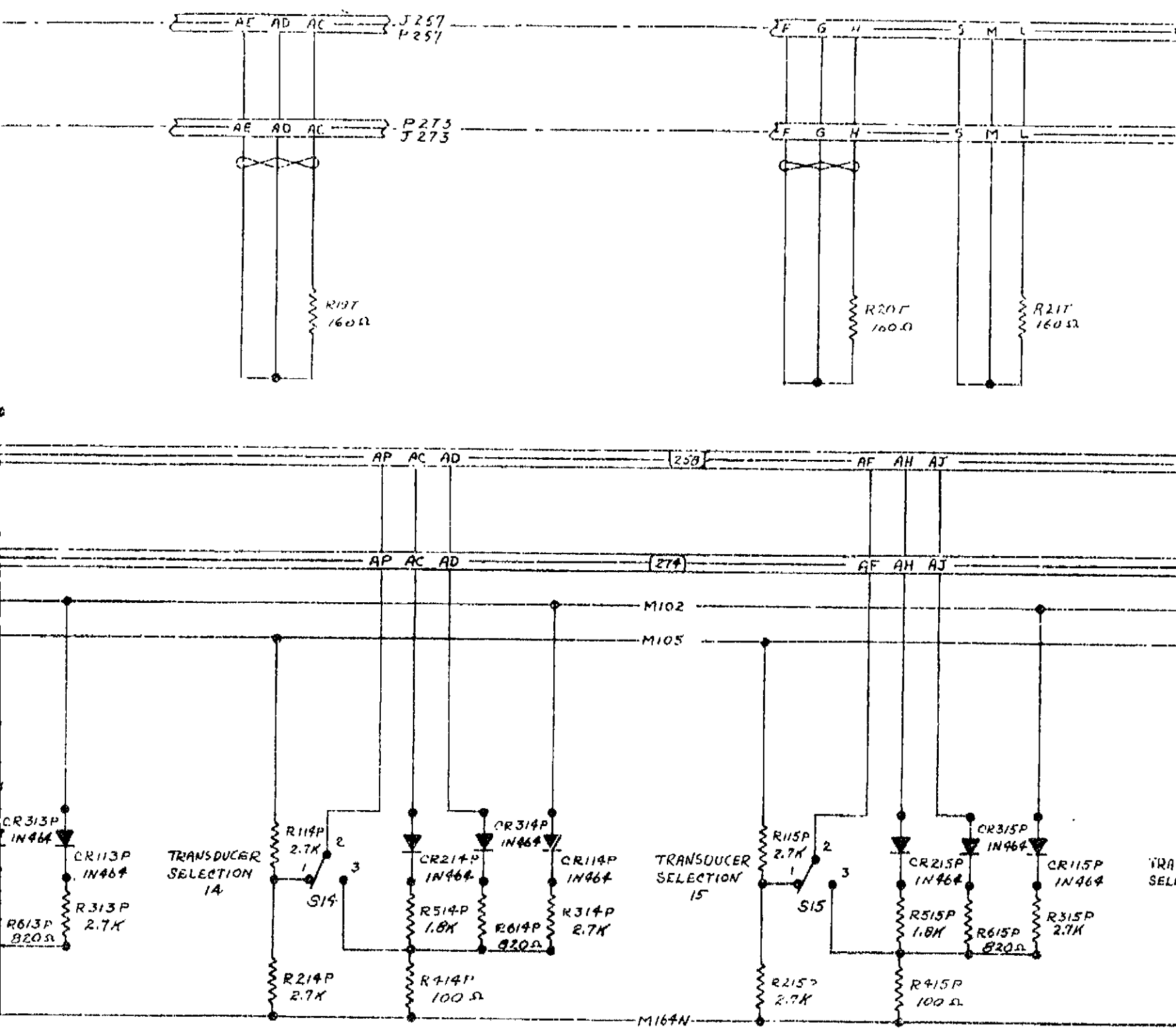


Figure 6-12. Data H

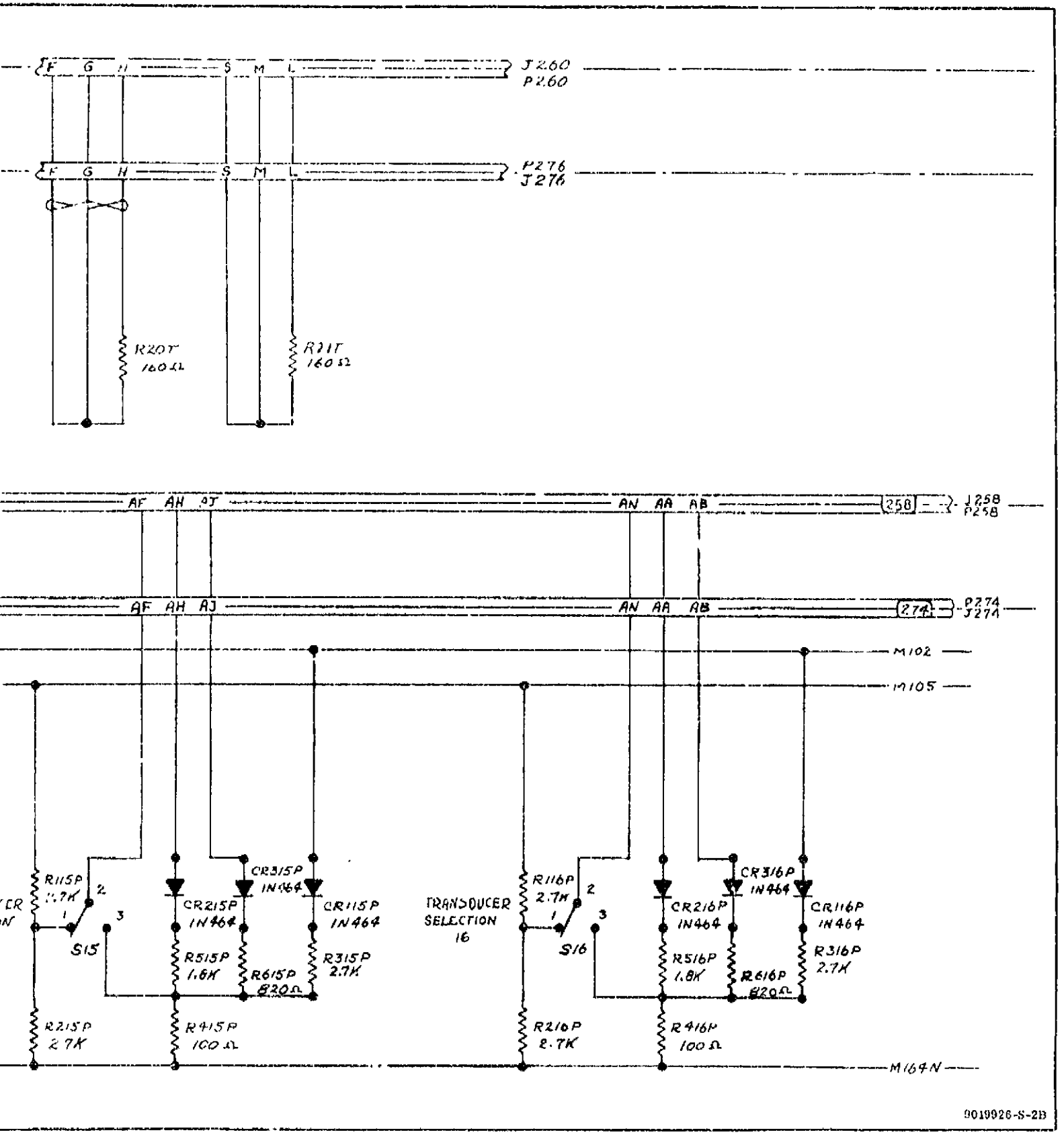
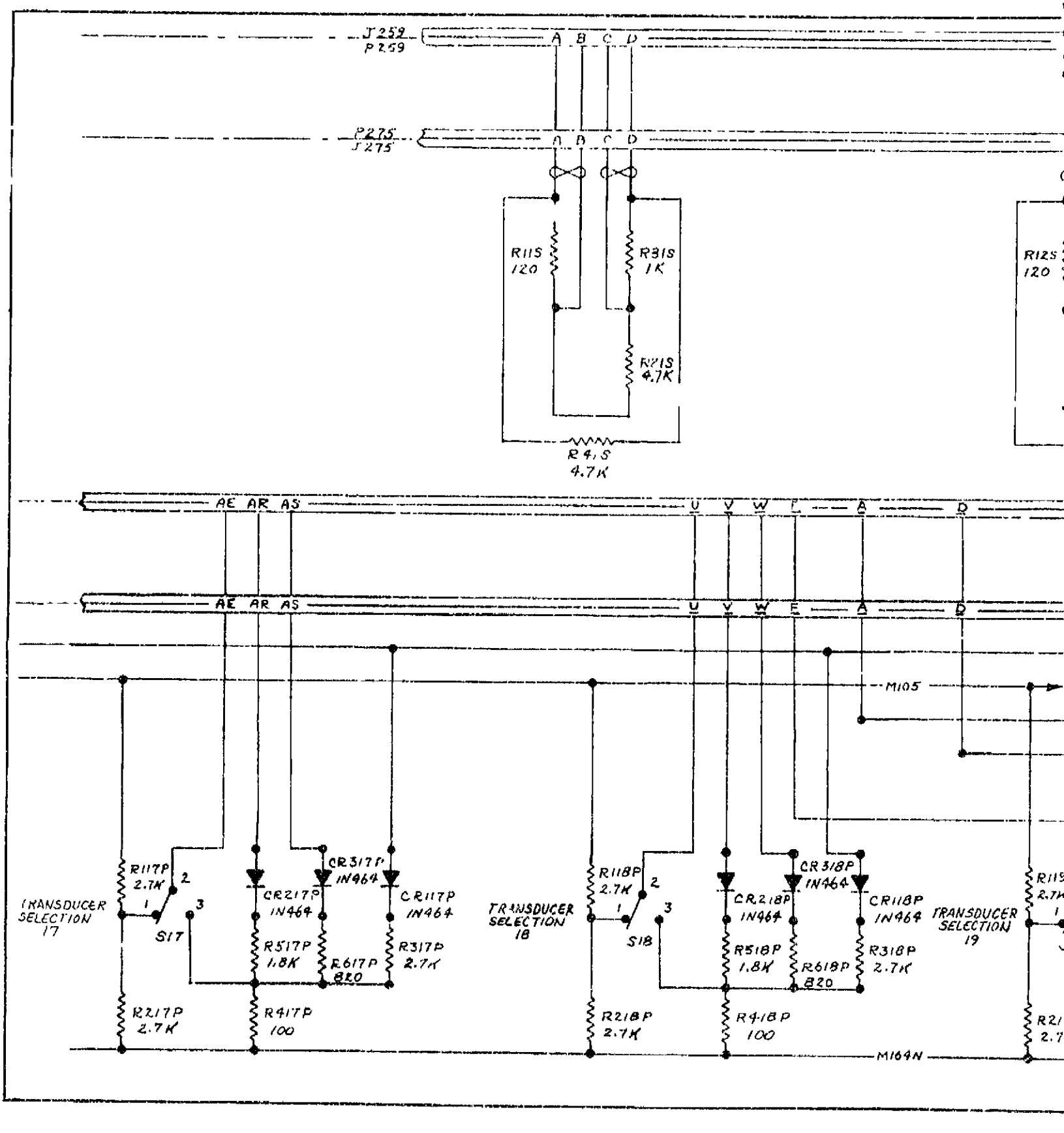


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 4 of 6)


J259
P259
P275
J275
A B C D
R11S 120
R31S 1K
R21S 4.7K
R41S 4.7K
R12S 120
AE AR AS
U V W E A D
M105
M164N
R117P 2.7K
S17
CR217P IN464
CR317P IN464
CR117P IN464
R517P 1.8K
R617P 820
R317P 2.7K
R217P 2.7K
R417P 100
TRANSDUCER SELECTION 17
R118P 2.7K
S18
CR218P IN464
CR318P IN464
CR118P IN464
R518P 1.8K
R618P 820
R318P 2.7K
R218P 2.7K
R418P 100
TRANSDUCER SELECTION 18
TRANSDUCER SELECTION 19

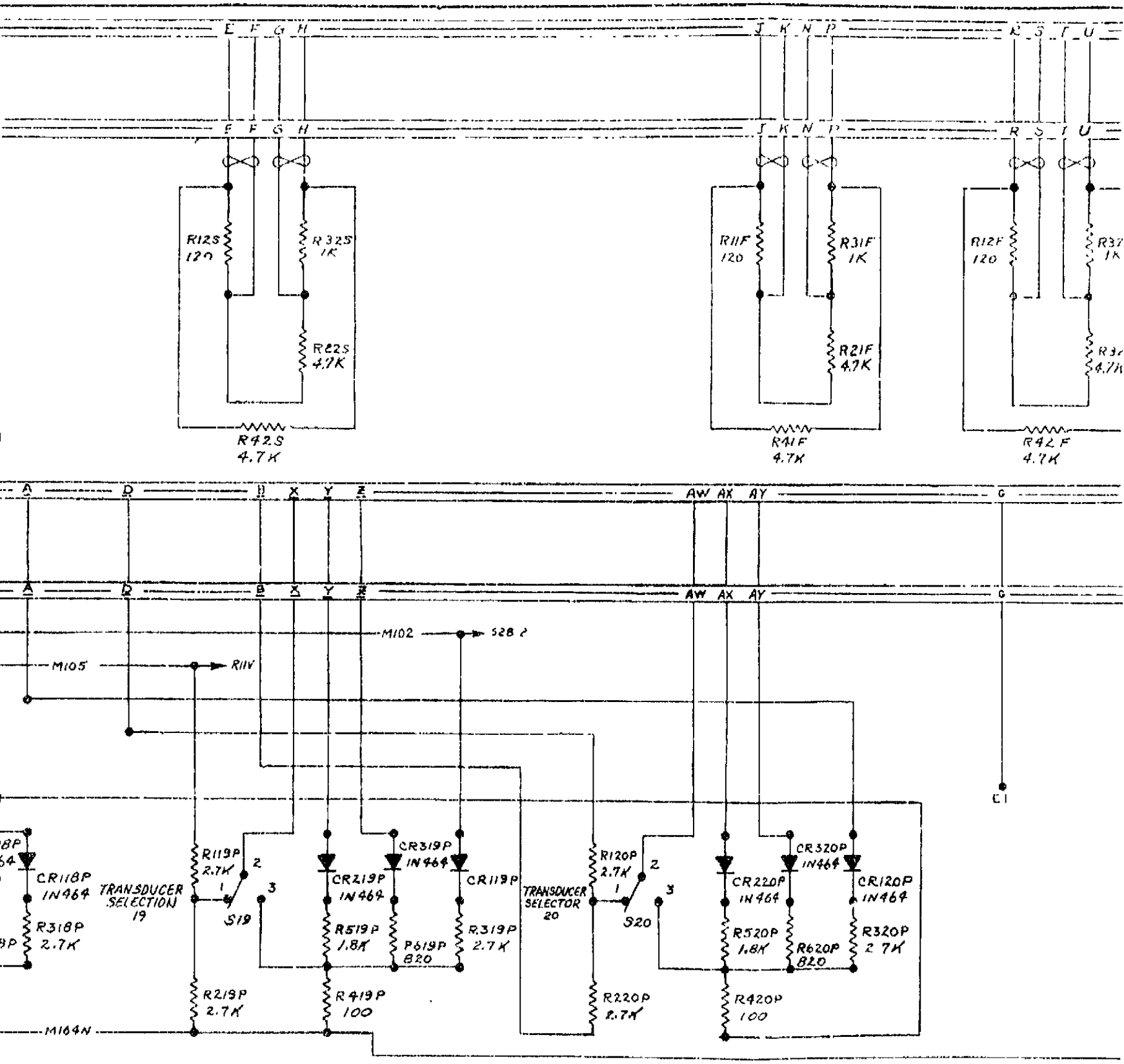


Figure 6-12. Data I

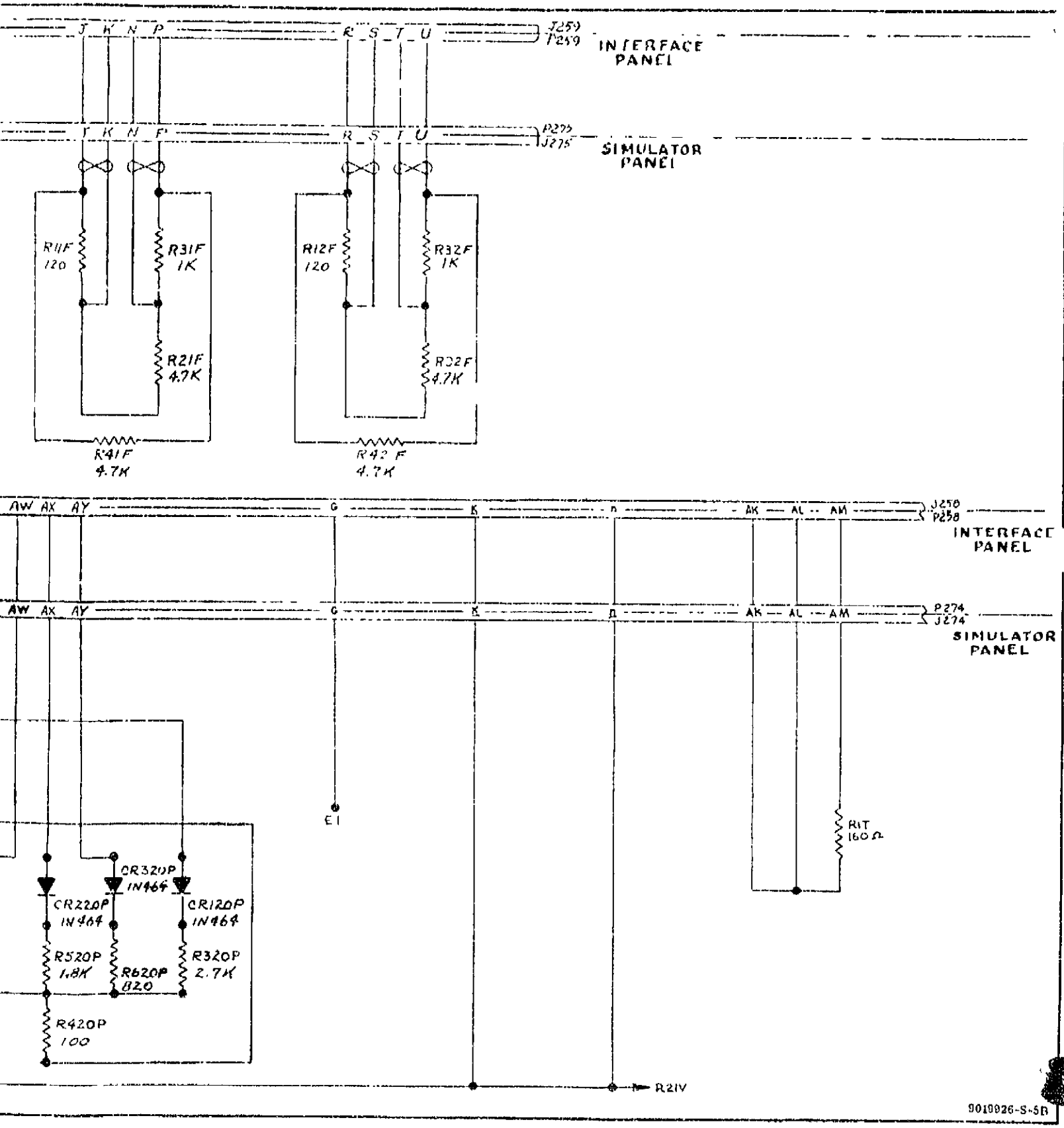
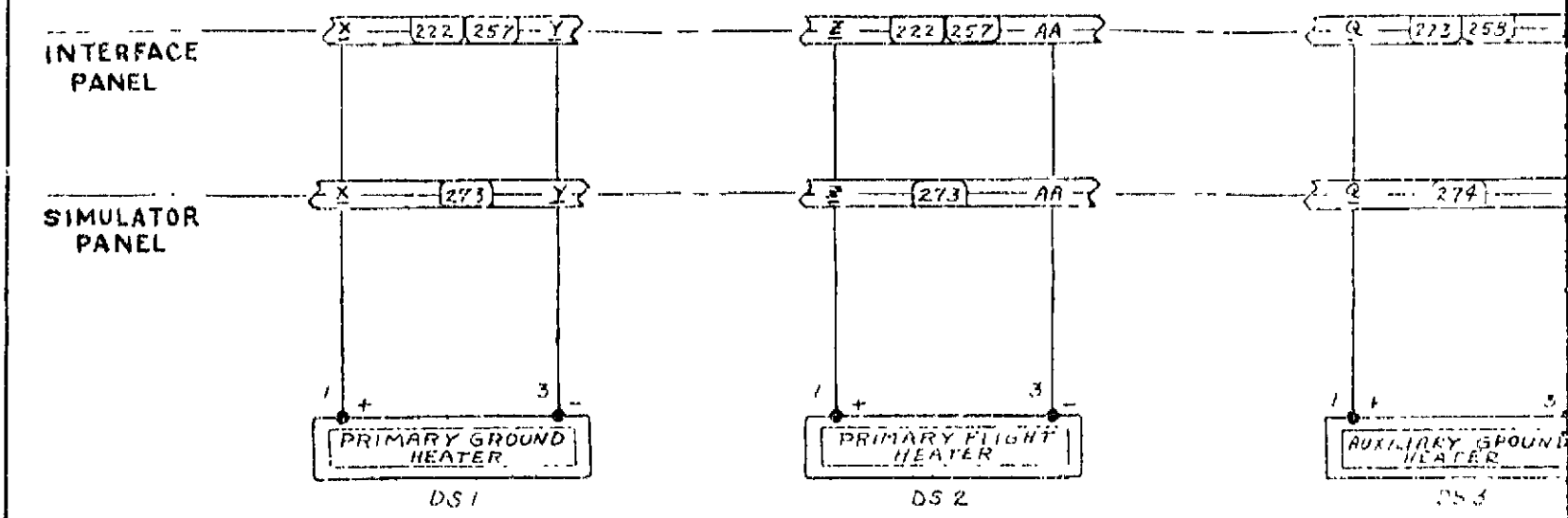
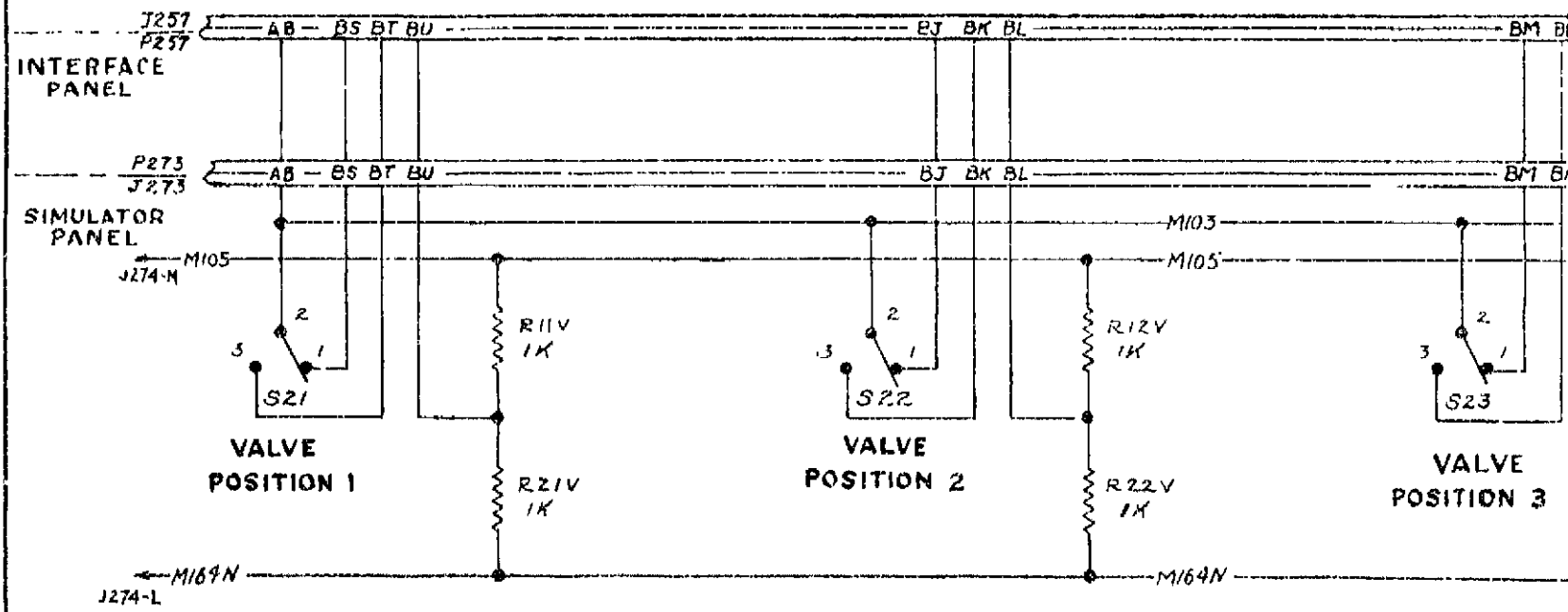


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 5 of 6)


INTERFACE PANEL
SIMULATOR PANEL
X
222
257
Y
Z
AA
Q
273
258
274
PRIMARY GROUND HEATER
PRIMARY FLIGHT HEATER
AUXILIARY GROUND HEATER
DS 1
DS 2
DS 3


J257
P257
INTERFACE PANEL
P273
J273
SIMULATOR PANEL
AB BS BT BU
BJ BK BL
BM
M105
J274-M
M103
R11V 1K
R12V 1K
R21V 1K
R22V 1K
S21
S22
S23
VALVE POSITION 1
VALVE POSITION 2
VALVE POSITION 3
M164N
J274-L

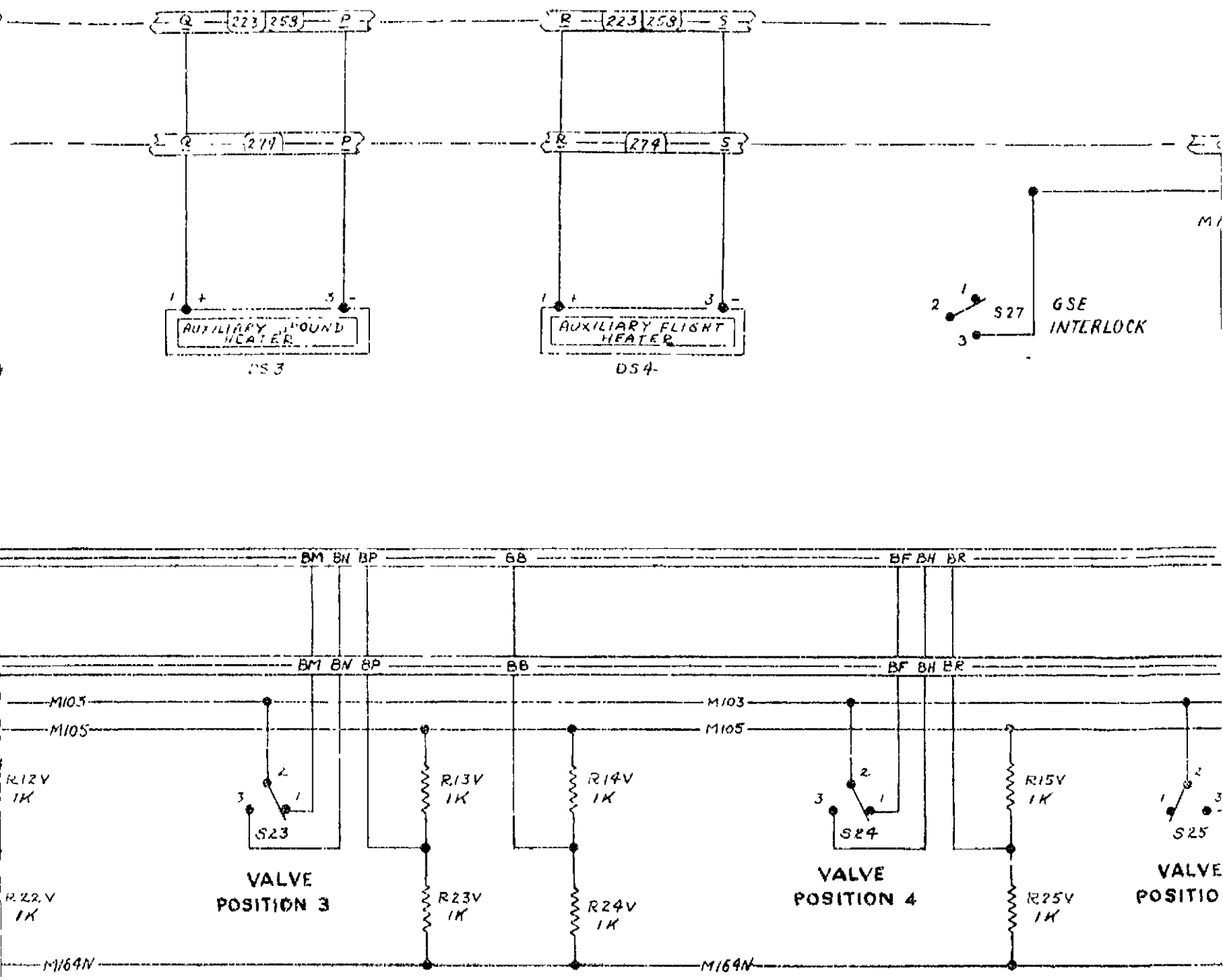

Q
223
259
P
R
223
259
S
279
AUXILIARY GROUND HEATER
DS3
AUXILIARY FLIGHT HEATER
DS4
S27
GSE INTERLOCK
BM BN BP
BB
BF BH BR
M103
M105
R12V 1K
R13V 1K
R14V 1K
R15V 1K
S23
S24
S25
VALVE POSITION 3
VALVE POSITION 4
R22V 1K
R23V 1K
R24V 1K
R25V 1K
M164N

Figure 6-1

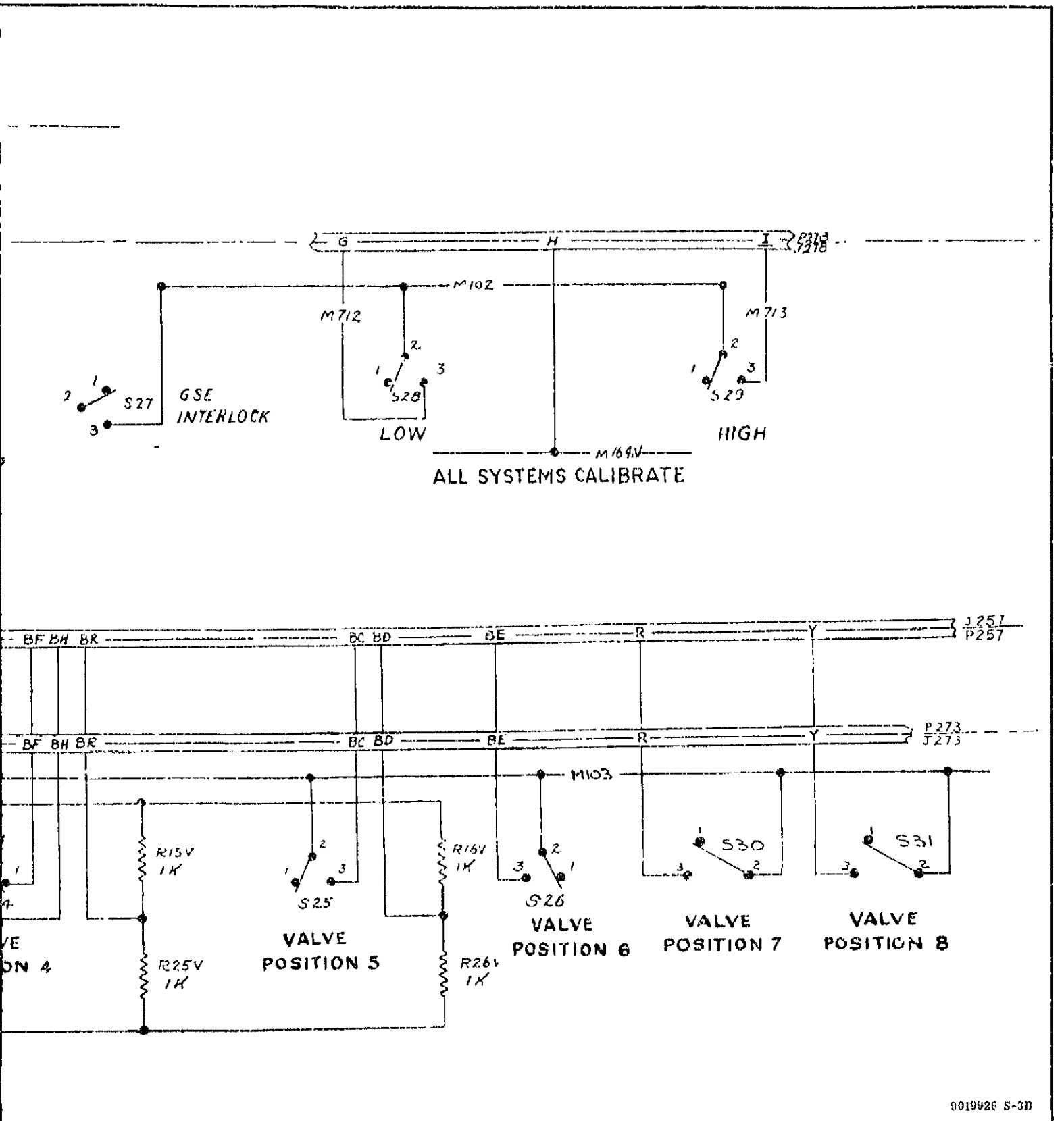


Figure 6-12. Data Recorder Console Electrical Schematic (Sheet 6 of 6)

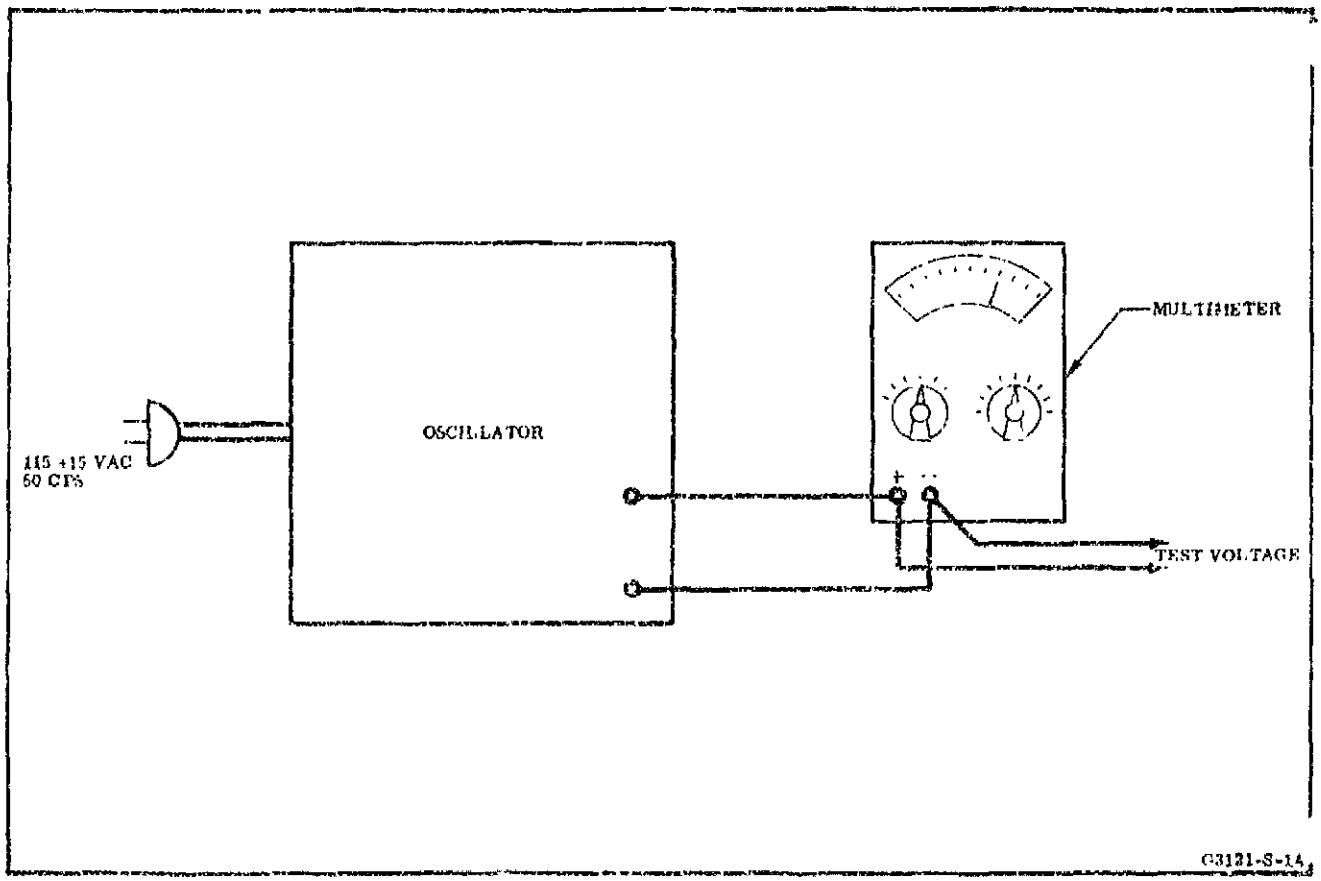


Figure 6-13. Oscillograph Test Circuit

6-23. CALIBRATION REQUIREMENTS.

6-24. The power distribution panel voltmeter must be checked to ensure an accuracy of two percent of full scale.

6-25. PREPARING FOR STORAGE.

6-26. Prepare console for storage as follows:

a. Disconnect external electrical cables from console and install protective caps on cables.

b. Stow electrical cables in console. (Refer to paragraph 6-11.)

c. Install protective caps on console interface receptacles.

d. Cover console with greaseproof barrier material (MIL-B-121, Grade A), or equivalent, and seal at bottom edge.

6-27. MAINTENANCE REQUIREMENTS FOR DATA RECORDER CONSOLE COMPONENTS.

6-28. Maintenance of components consists of removing and installing panels, loading recorders, lubricating, and cleaning. Function-test console subsequent to component repair or replacement. See figures 6-14 through 6-17 for panel and console cable wiring diagrams.

6-29. REMOVING AND INSTALLING ELECTRICAL PANELS.

6-30. Removal and installation methods for each of the console panels are as follows:

a. Open rear access door.

b. Disconnect cable assemblies from component to be removed.

c. Remove applicable retaining screws at front of console and slide unit from console.

d. Reinstall in the reverse order of removal and torque screws to 36-46 inch-pounds.

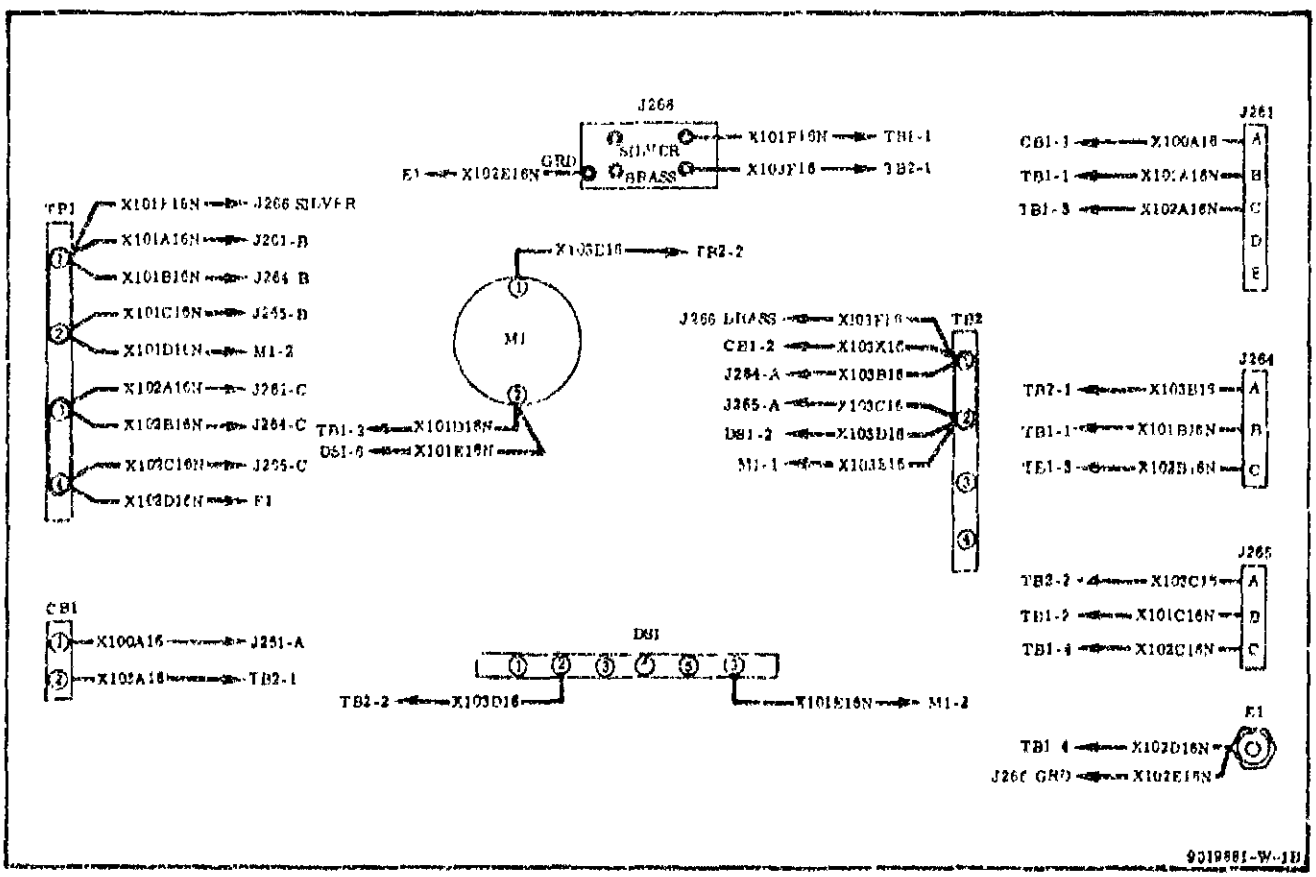


Figure 6-14. Power Distribution Panel Wiring Diagram

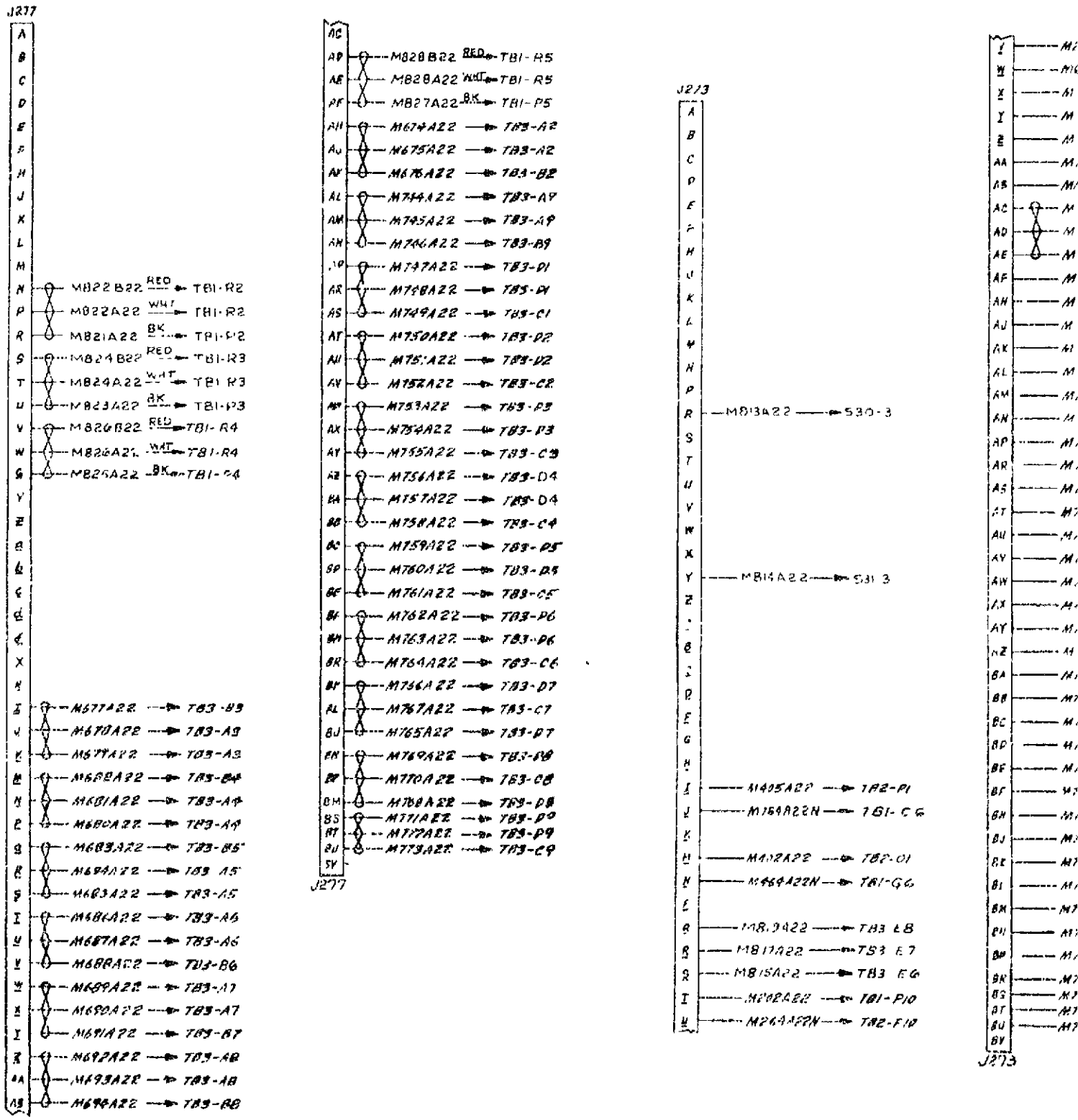
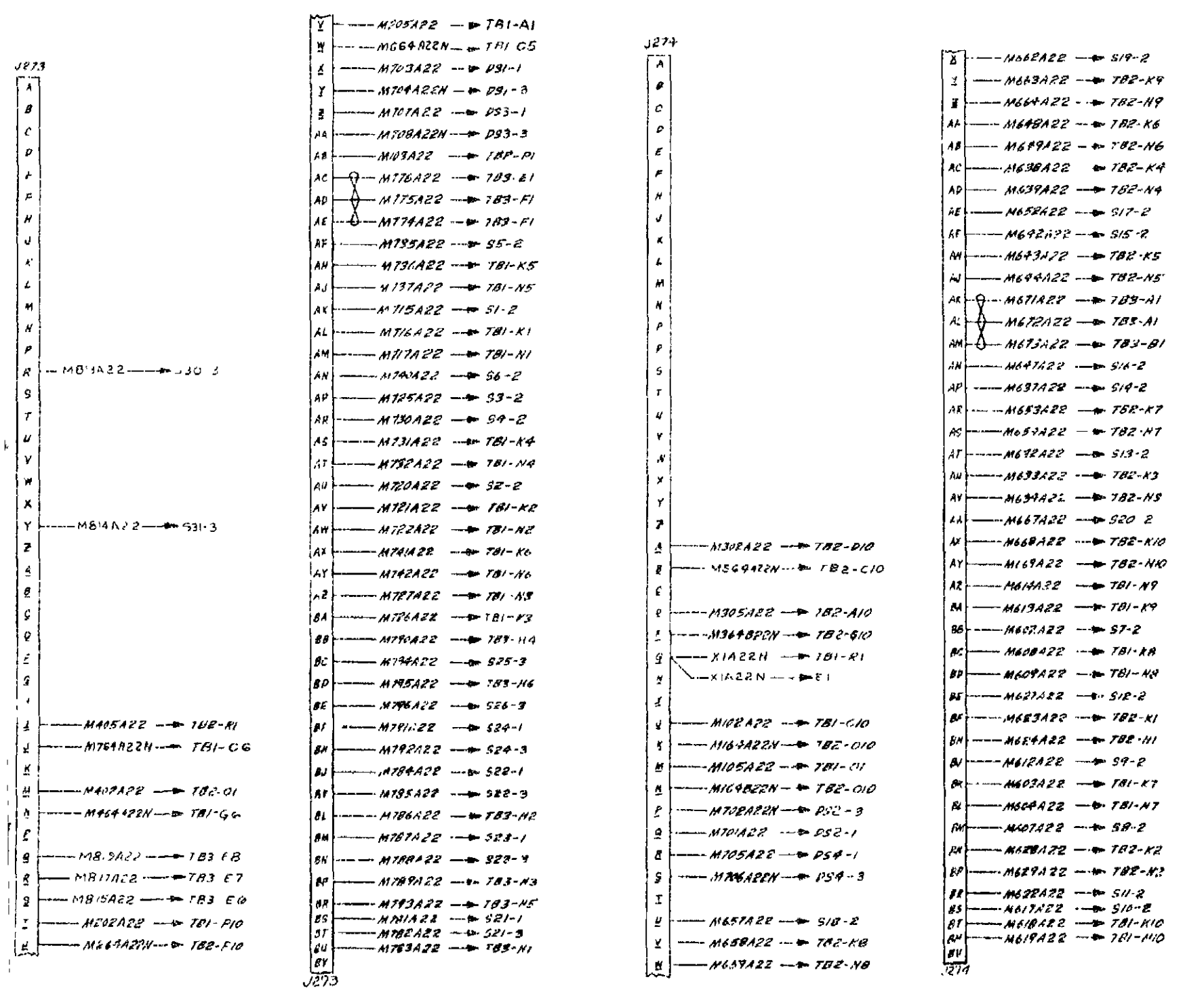
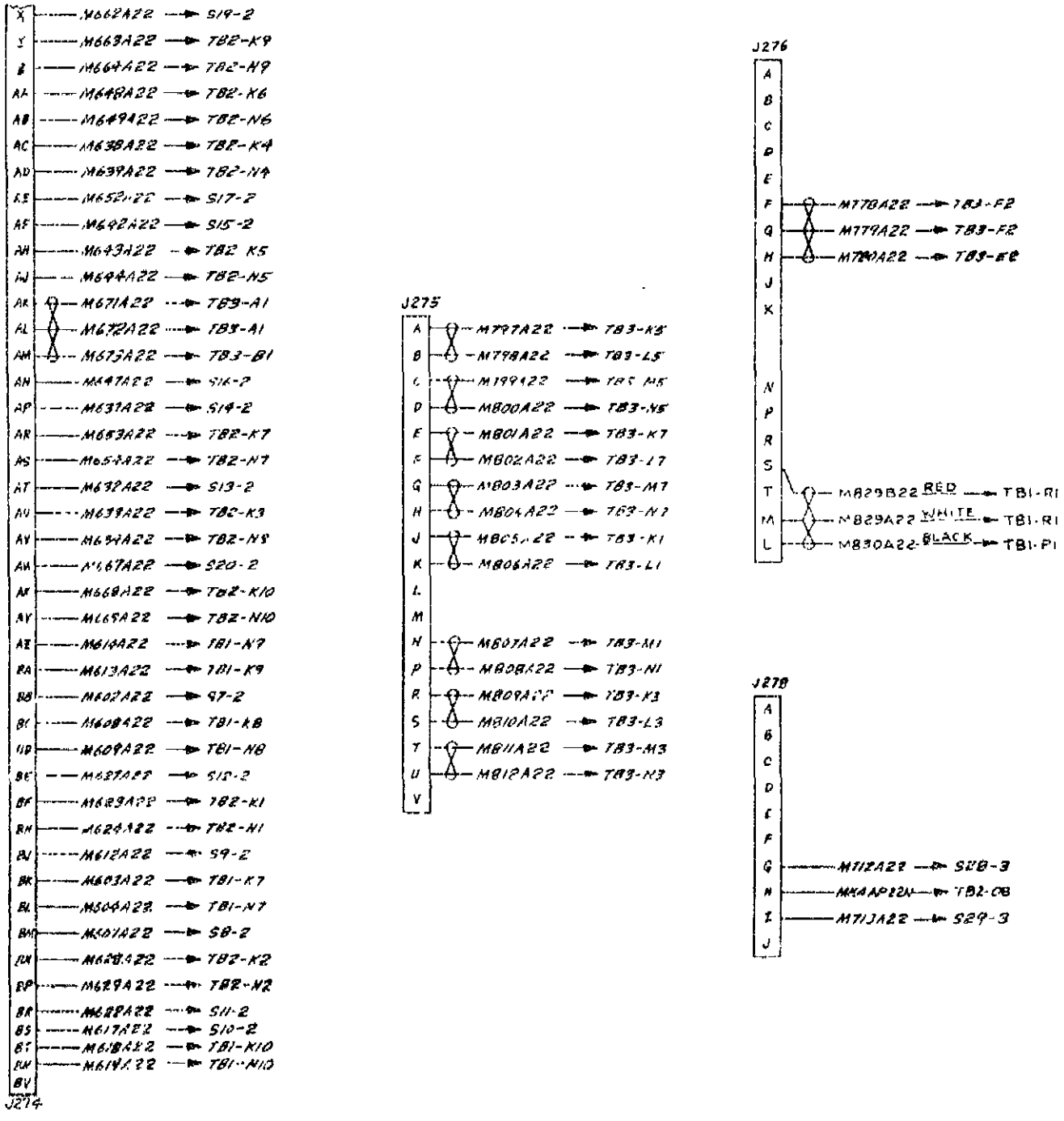
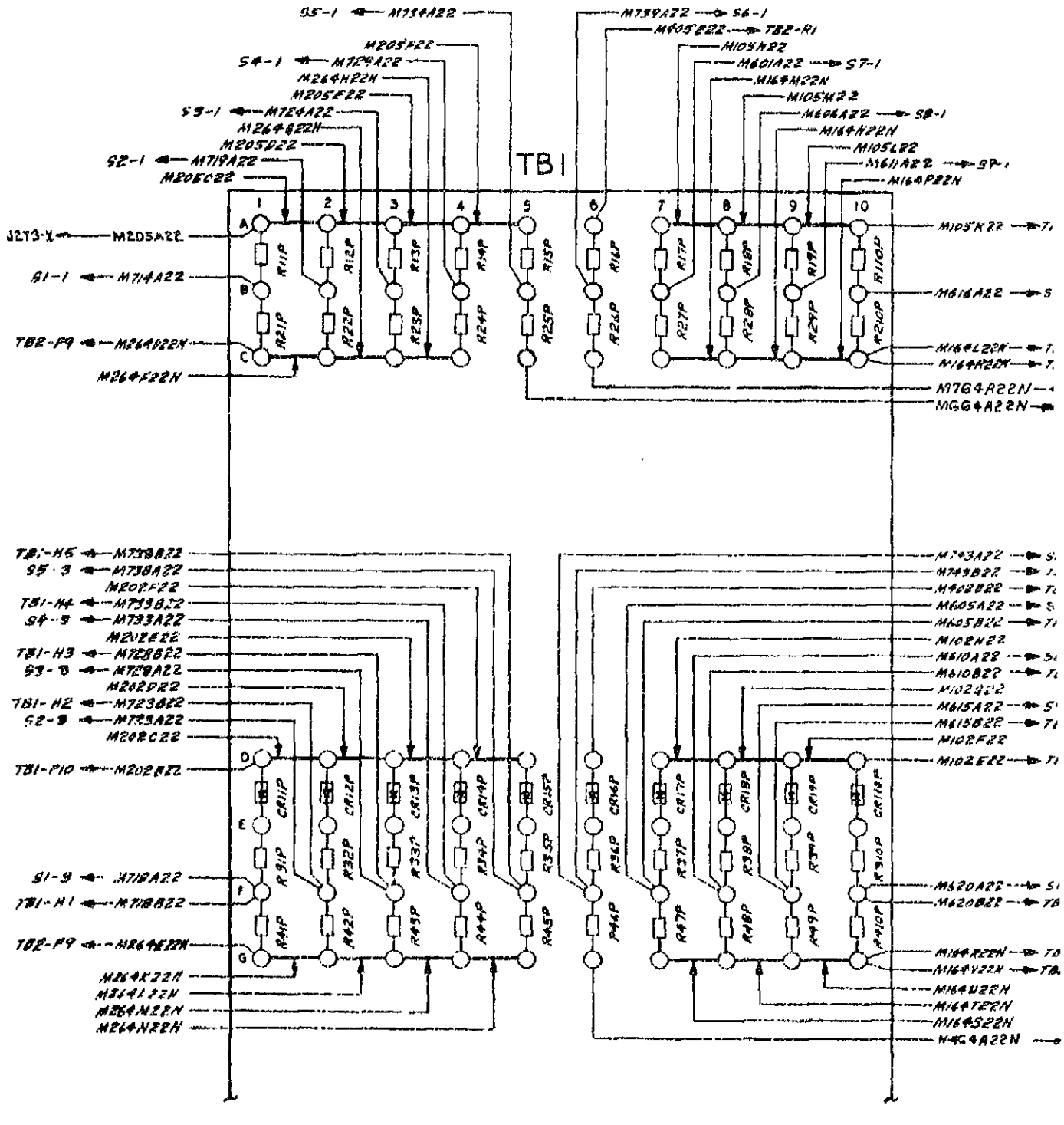


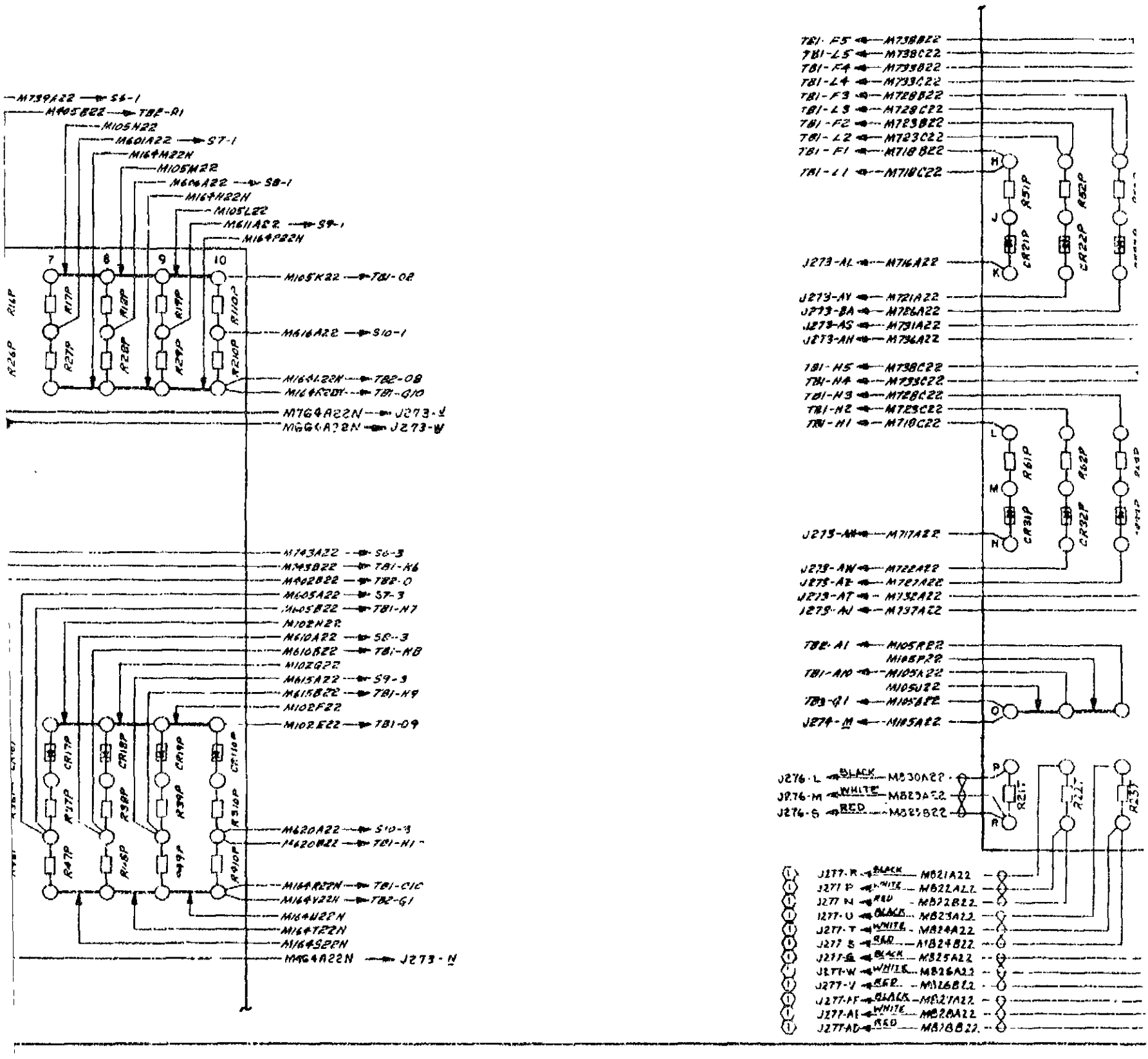
Figure 6-15. Flight Instrumentation Simulator Panel Wiring Diagram (Sheet 1 of 5)


J273
M814A22 → J30 3
M814A22 → S31-3
M405A22 → TB2-R1
M764A22N → TB1-C6
M407A22 → TB2-01
M464422N → TB1-G6
M815A22 → TB3 E8
M811A22 → TB3 E7
M815A22 → TB3 E6
M202A22 → TB1-P10
M264A22N → TB2-F10
M705A22 → TB1-A1
MG64A22N → TB1 C5
M703A22 → DS1-1
M704A22N → DS1-3
M707A22 → DS3-1
M708A22N → DS3-3
M703A22 → TBP-P1
M776A22 → TB3-E1
M775A22 → TB3-F1
M774A22 → TB3-F1
M735A22 → S5-2
M736A22 → TB1-K5
M737A22 → TB1-N5
M715A22 → S1-2
M716A22 → TB1-K1
M717A22 → TB1-N1
M740A22 → S6-2
M725A22 → S3-2
M730A22 → S4-2
M731A22 → TB1-K4
M732A22 → TB1-N4
M720A22 → S2-2
M721A22 → TB1-K2
M722A22 → TB1-N2
M741A22 → TB1-K6
M742A22 → TB1-N6
M727A22 → TB1-K3
M726A22 → TB1-P3
M790A22 → TB3-H4
M734A22 → S25-3
M795A22 → TB3-H6
M796A22 → S26-3
M791A22 → S24-1
M792A22 → S24-3
M784A22 → S22-1
M795A22 → S22-3
M786A22 → TB3-H2
M787A22 → S23-1
M788A22 → S23-3
M789A22 → TB3-H3
M793A22 → TB3-H5
M781A22 → S21-1
M782A22 → S21-3
M783A22 → TB3-H1
J273
J274
M130A22 → TB2-P10
M5G9422N → TB2-C10
M305A22 → TB2-A10
M364B22N → TB2-G10
X1A22N → TB1-R1
X1A22N → E1
M102A22 → TB1-C10
M163A22N → TB2-010
M105A22 → TB1-01
M1G9B22N → TB2-010
M702A22N → PS2-3
M701A22 → PS2-1
M705A22 → PS4-1
M706A22N → PS4-3
M657A22 → S18-2
M658A22 → TB2-K8
M639A22 → TB2-N8
M662A22 → S19-2
M663A22 → TB2-K9
M664A22 → TB2-N9
M648A22 → TB2-K6
M649A22 → TB2-N6
M638A22 → TB2-K4
M639A22 → TB2-N4
M652A22 → S17-2
M642A22 → S15-2
M643A22 → TB2-K5
M644A22 → TB2-N5
M671A22 → TB3-A1
M672A22 → TB3-A1
M673A22 → TB3-B1
M647A22 → S16-2
M637A22 → S19-2
M653A22 → TB2-K7
M652A22 → TB2-N7
M632A22 → S13-2
M633A22 → TB2-K3
M634A22 → TB2-N3
M667A22 → S20 2
M668A22 → TB2-K10
M669A22 → TB2-N10
M614A22 → TB1-N9
M619A22 → TB1-K9
M607A22 → S7-2
M608A22 → TB1-K8
M609A22 → TB1-N8
M627A22 → S12-2
M623A22 → TB2-K1
M624A22 → TB2-N1
M612A22 → S9-2
M603A22 → TB1-K7
M604A22 → TB1-N7
M607A22 → S8-2
M628A22 → TB2-K2
M629A22 → TB2-N2
M622A22 → S11-2
M617A22 → S10-2
M618A22 → TB1-K10
M619A22 → TB1-N10
J274

ring


J274
X M662A22 S19-2
Y M663A22 TB2-K9
Z M664A22 TB2-N9
AA M648A22 TB2-K6
AB M649A22 TB2-N6
AC M638A22 TB2-K4
AD M639A22 TB2-N4
AE M652A22 S17-2
AF M642A22 S15-2
AH M643A22 TB2 K5
AJ M644A22 TB2-N5
AK M671A22 TB3-A1
AL M672A22 TB3-A1
AM M673A22 TB3-B1
AN M647A22 S16-2
AP M637A22 S14-2
AR M653A22 TB2-K7
AS M654A22 TB2-N7
AT M632A22 S13-2
AU M633A22 TB2-K3
AV M634A22 TB2-N3
AW M667A22 S20-2
AX M668A22 TB2-K10
AY M669A22 TB2-N10
AZ M614A22 TB1-N7
BA M613A22 TB1-K9
BB M602A22 S7-2
BC M608A22 TB1-K8
BD M609A22 TB1-N8
BE M627A22 S12-2
BF M629A22 TB2-K1
BH M624A22 TB2-N1
BJ M612A22 S9-2
BK M603A22 TB1-K7
BL M604A22 TB1-N7
BM M601A22 S8-2
BN M628A22 TB2-K2
BP M629A22 TB2-N2
BR M688A22 S11-2
BS M617A22 S10-2
BT M618A22 TB1-K10
BU M619A22 TB1-N10
BV
J275
A M797A22 TB3-K5
B M798A22 TB3-L5
C M799A22 TB3-M5
D M800A22 TB3-N5
E M801A22 TB3-K7
F M802A22 TB3-L7
G M803A22 TB3-M7
H M804A22 TB3-N7
J M805A22 TB3-K1
K M806A22 TB3-L1
L
M
N M807A22 TB3-M1
P M808A22 TB3-N1
R M809A22 TB3-K3
S M810A22 TB3-L3
T M811A22 TB3-M3
U M812A22 TB3-N3
V
J276
A
B
C
D
E
F M778A22 TB3-F2
G M779A22 TB3-F2
H M780A22 TB3-E2
J
K
N
P
R
S
T M829B22 RED TB1-R1
M M829A22 WHITE TB1-R1
L M830A22 BLACK TB1-P1
J278
A
B
C
D
E
F
G M712A22 S28-3
H MKAAP22N TB2-C8
T M713A22 S29-3
J


TB1
S5-1
M739A22
S6-1
M605B22
TB2-R1
M205F22
M105N22
S4-1
M729A22
M601A22
S7-1
M264H22N
M164M22N
M205F22
M105M22
S3-1
M724A22
M604A22
S8-1
M264B22N
M164N22N
M205D22
M105L22
S2-1
M719A22
M611A22
S9-1
M206C22
M164P22N
M205M22
M105K22
S1-1
M714A22
M618A22
TB2-P9
M264B22N
M164L22N
M164R22N
M264F22N
M17G4A22N
MGG4A22N
TB1-H5
M739B22
S5-3
M738A22
M202F22
TB1-H4
M733B22
S4-3
M733A22
M202E22
TB1-H3
M728B22
S3-3
M729A22
M202D22
TB1-H2
M723B22
S2-3
M723A22
M202C22
TB1-P10
M202B22
S1-3
M718A22
TB1-H1
M718B22
TB2-P9
M264E22N
M264K22N
M264L22N
M264M22N
M264N22N
M743A22
M749B22
M602B22
M605A22
M605B22
M102N22
M610A22
M610B22
M102Q22
M615A22
M615B22
M102F22
M102E22
M620A22
M620B22
M164R22N
M164V22N
M164U22N
M164T22N
M164S22N
M4G4A22N


M739A22 → S6-1
M605B22 → TB2-A1
M105N22
M601A22 → S7-1
M164M22N
M105M22
M606A22 → S8-1
M164N22N
M105L22
M611A22 → S9-1
M164P22N
7
8
9
10
M165K22 → TB1-D2
M616A22 → S10-1
M164L22N → TB2-D8
M164R22N → TB1-G10
M746A22N → J273-V
M666A22N → J273-W
M743A22 → S6-3
M743B22 → TB1-K6
M602B22 → TB2-D
M605A22 → S7-3
M605B22 → TB1-N7
M102N22
M610A22 → S8-3
M610B22 → TB1-M8
M102G22
M615A22 → S9-3
M615B22 → TB1-K9
M102F22
M102E22 → TB1-D9
M620A22 → S10-3
M620B22 → TB1-N10
M164R22N → TB1-C10
M164V22N → TB2-G1
M164W22N
M164T22N
M164S22N
M666A22N → J273-N
TB1-F5 → M738B22
TB1-L5 → M738C22
TB1-F4 → M733B22
TB1-L4 → M733C22
TB1-F3 → M728B22
TB1-L3 → M728C22
TB1-F2 → M723B22
TB1-L2 → M723C22
TB1-F1 → M718B22
TB1-L1 → M718C22
J273-AL → M716A22
J273-AY → M721A22
J273-BA → M726A22
J273-AS → M731A22
J273-AH → M736A22
TB1-H5 → M738C22
TB1-N4 → M733C22
TB1-H3 → M728C22
TB1-N2 → M723C22
TB1-H1 → M718C22
J273-AN → M717A22
J273-AW → M722A22
J273-AE → M727A22
J273-AT → M732A22
J273-AJ → M737A22
TB2-A1 → M105R22
M106P22
TB1-A10 → M105K22
M105U22
TB3-Q1 → M105B22
J274-M → M105A22
J276-L BLACK → M830A22
J276-M WHITE → M829A22
J276-S RED → M827B22
J277-R BLACK → M821A22
J277-P WHITE → M822A22
J277-N RED → M822B22
J277-U BLACK → M823A22
J277-T WHITE → M824A22
J277-S RED → M824B22
J277-G BLACK → M825A22
J277-W WHITE → M826A22
J277-V RED → M826B22
J277-AF BLACK → M827A22
J277-AE WHITE → M828A22
J277-AD RED → M828B22

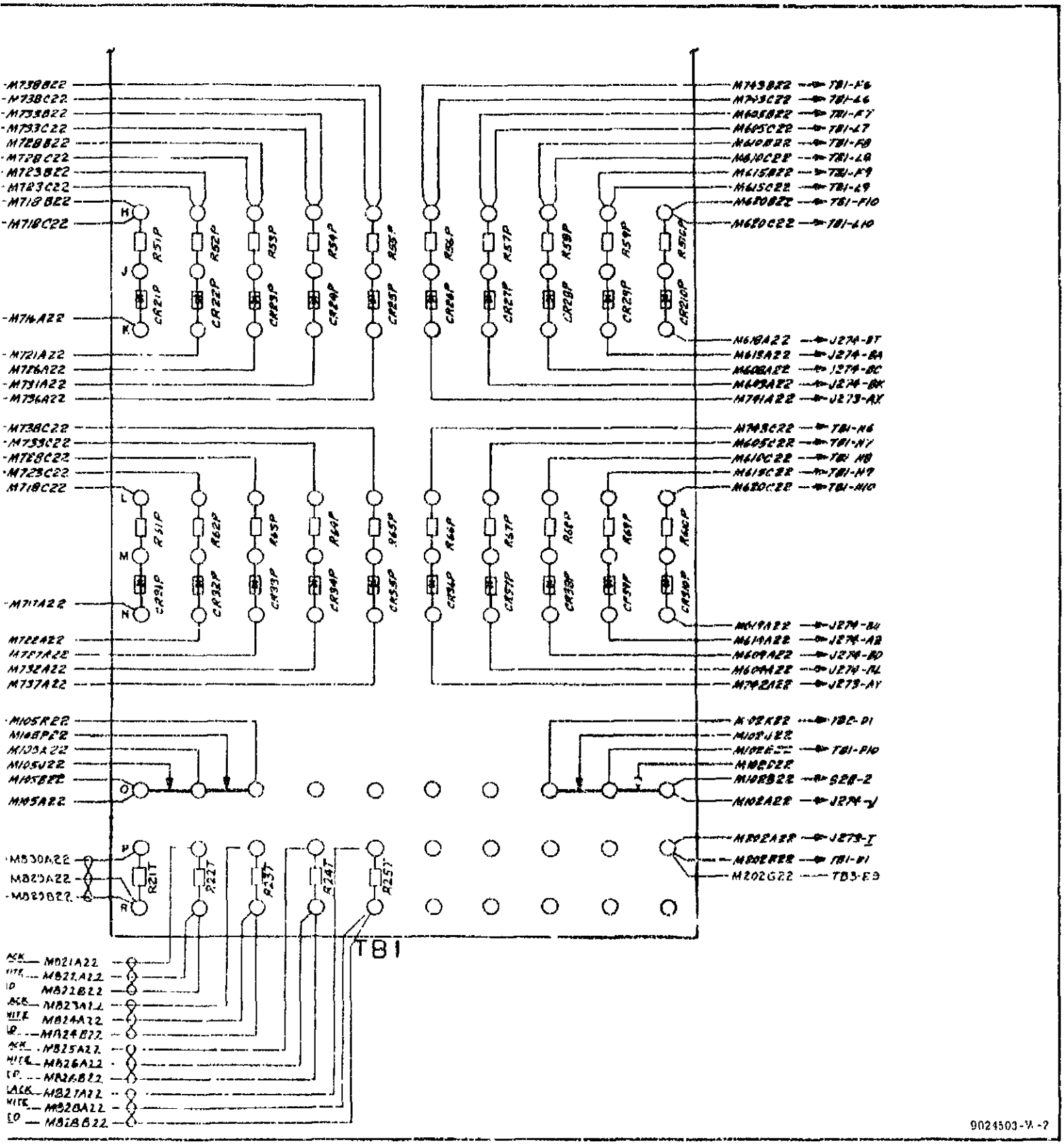
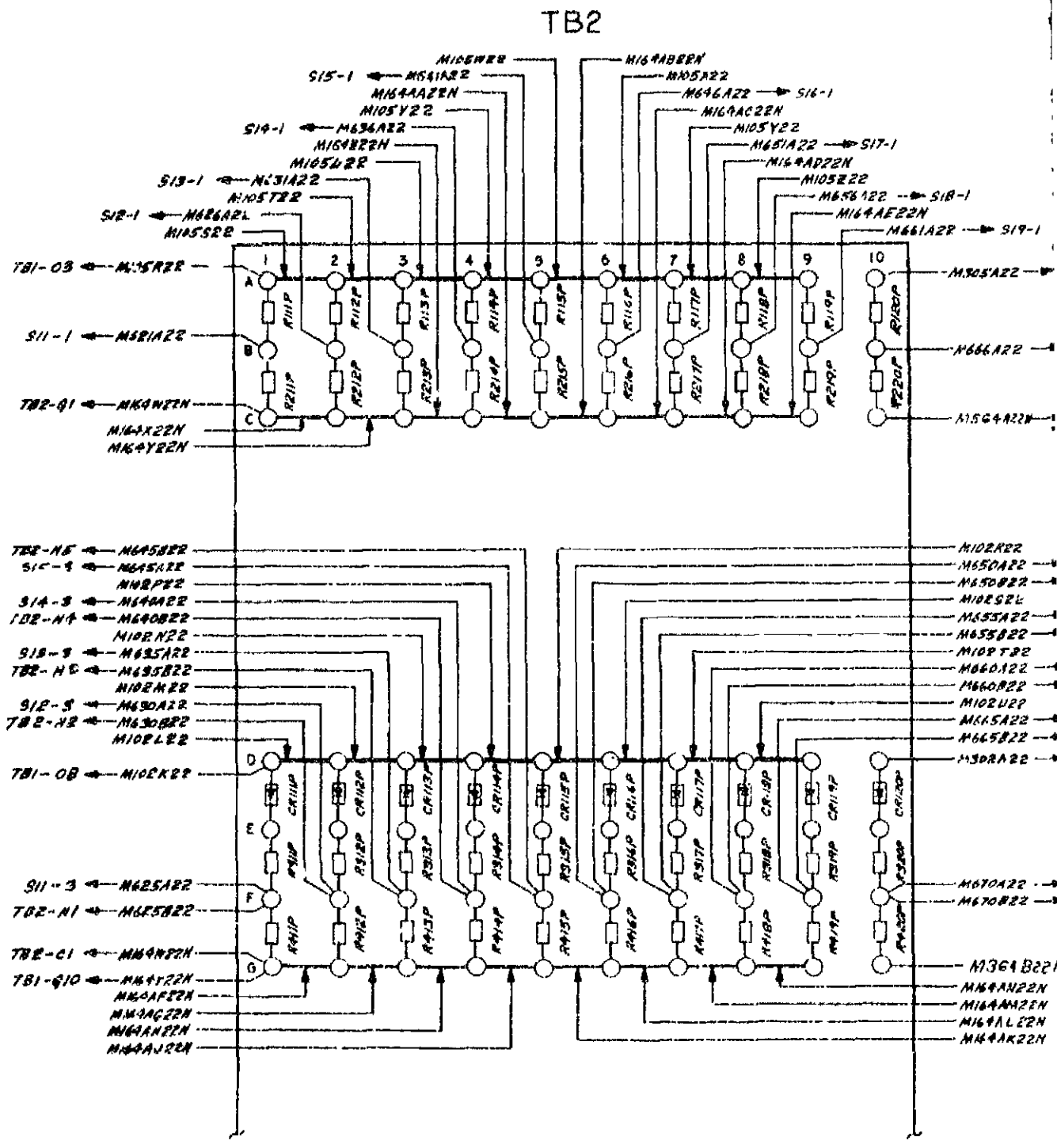
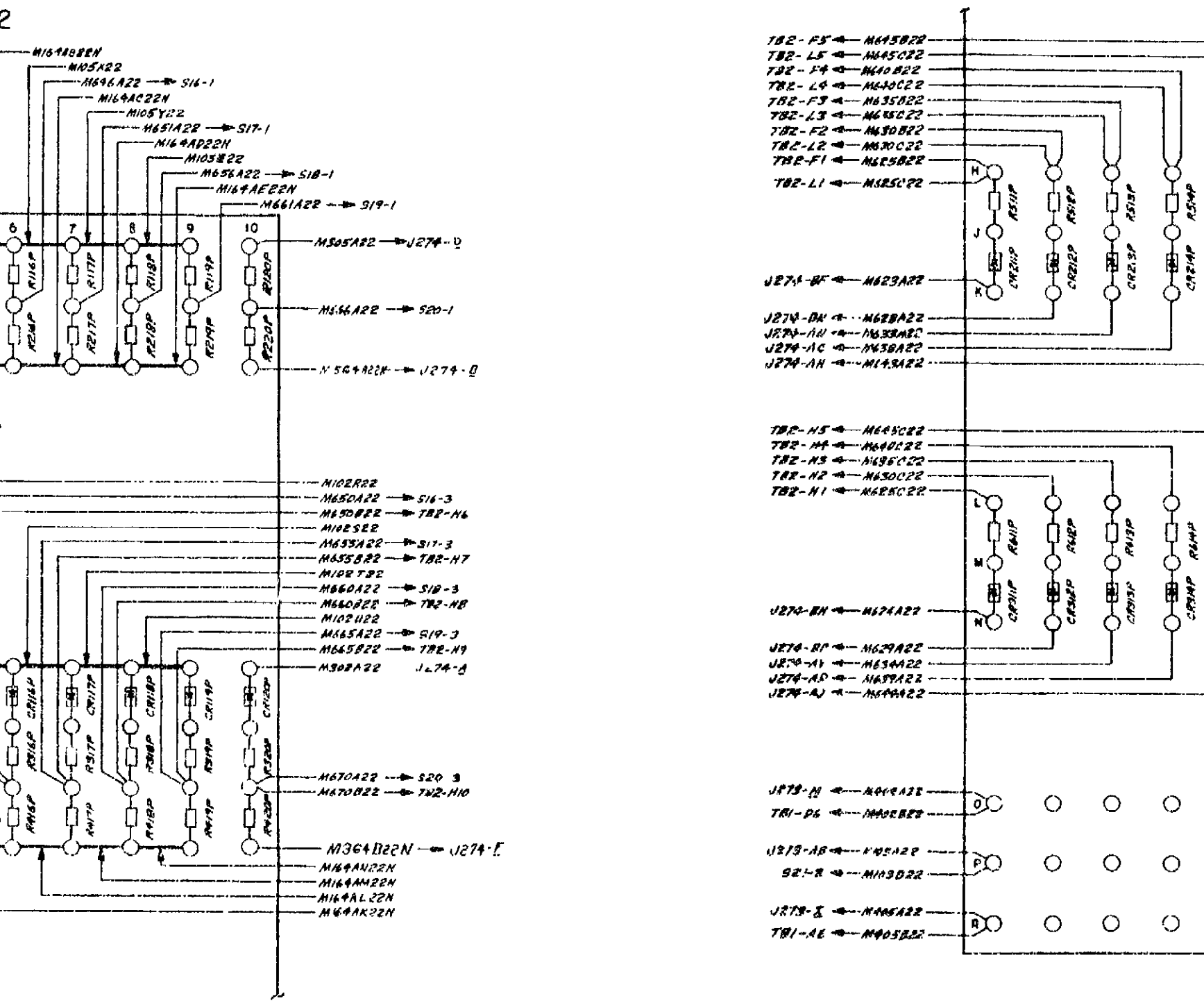
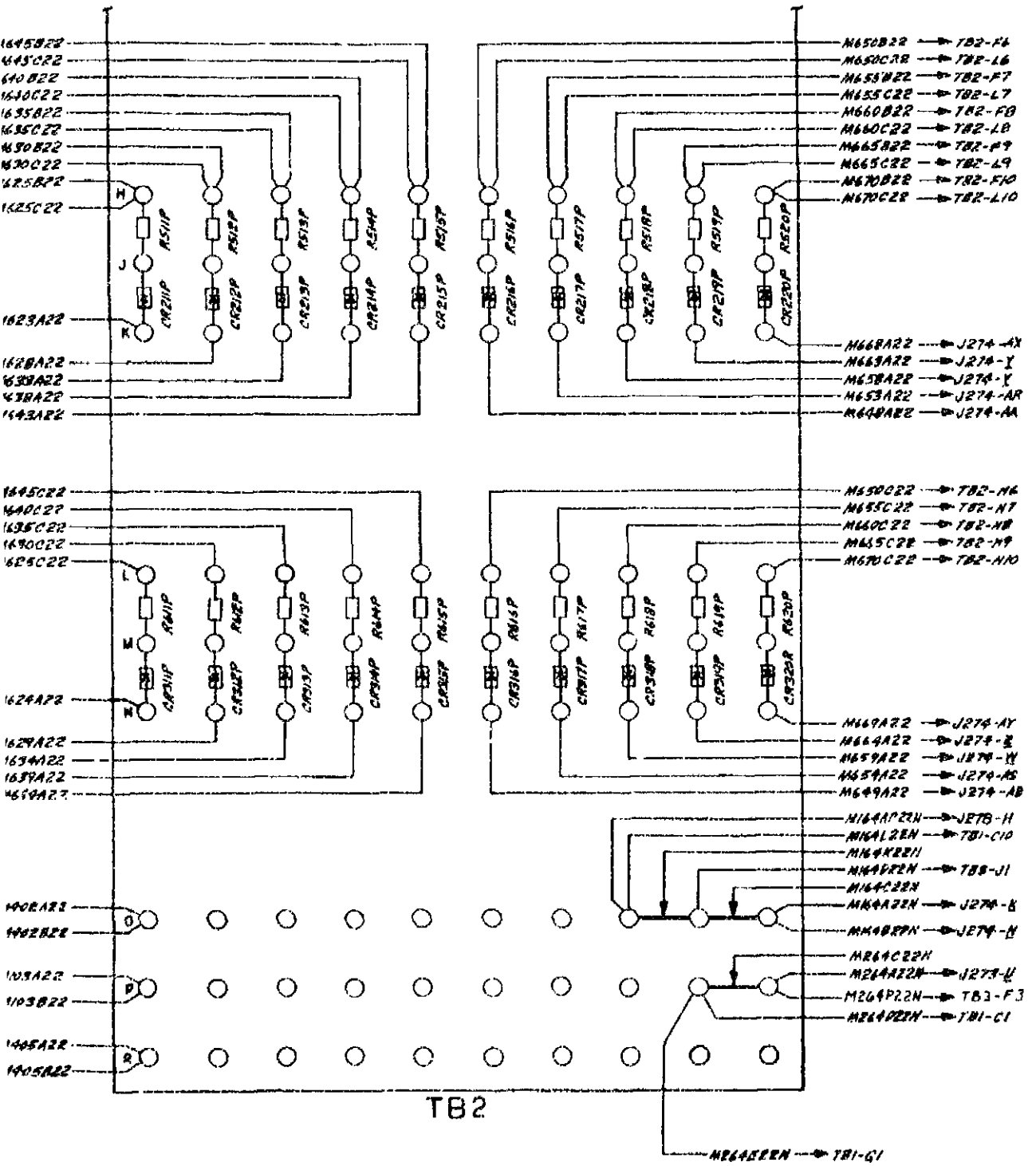


Figure 6-15. Flight Instrumentation Simulator Panel Wiring Diagram (Sheet 2 of 5)

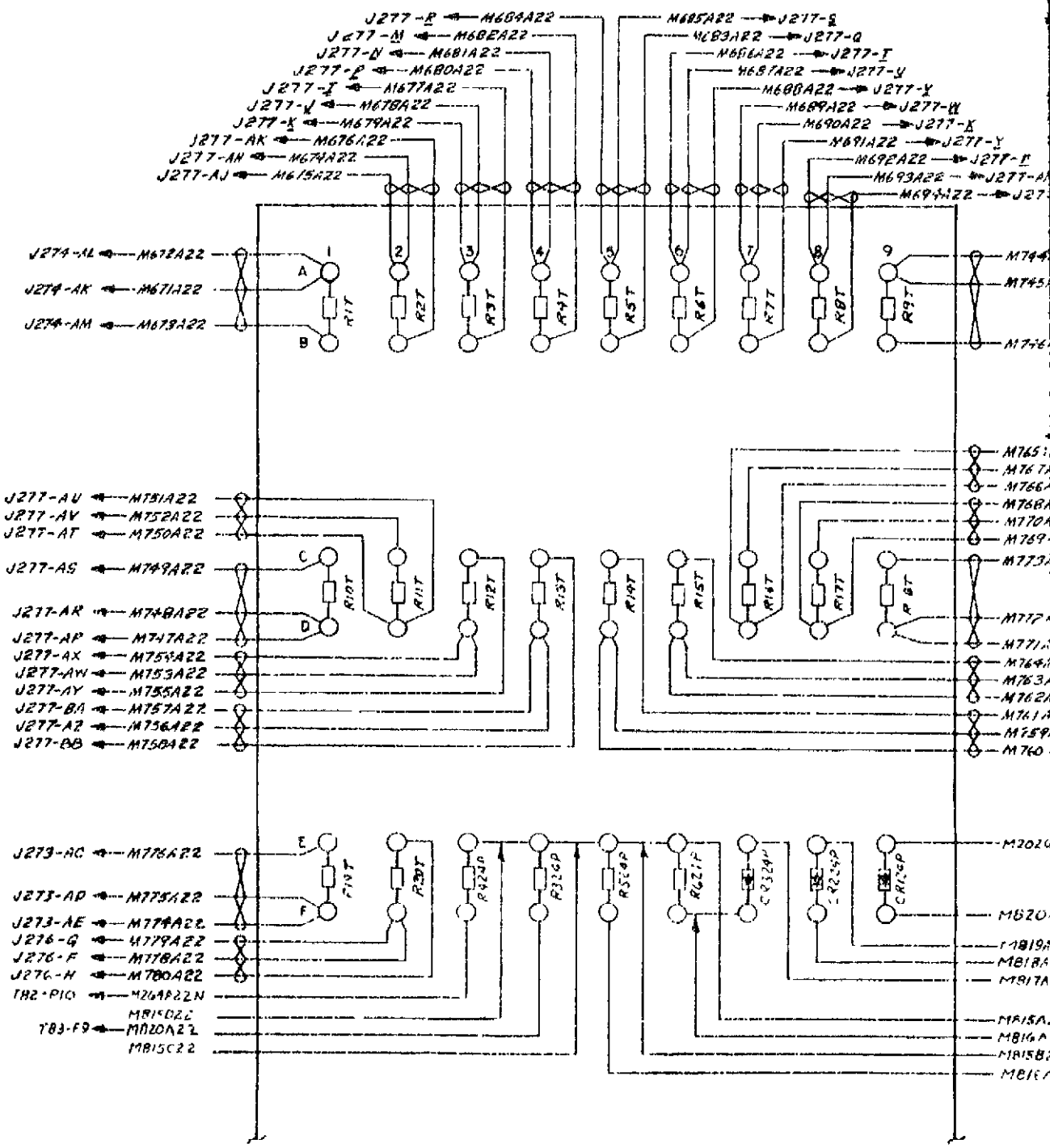

TB2
M1084B22
S15-1
M641A22
M644AA22N
M105Y22
S14-1
M636A22
M1648Z2N
M1054Z2
S13-1
M631A22
M105T22
S12-1
M626A22L
M105S22
TB1-03
M635R22
S11-1
M621A22
TB2-01
M644N22N
M644X22N
M644Y22N
M644BB2N
M646A22
M644AC22N
M105Y22
M651A22
M644AD22N
M105Z22
M656A22
M644AE22N
M661A22
M905A22
M666A22
M1564A22N
TB2-N5
M645B22
S15-3
M645A22
M102P22
S14-3
M640A22
TB2-N4
M640B22
M102N22
S18-3
M635A22
TB2-N5
M635B22
M102M22
S12-3
M630A22
TB2-N3
M630B22
M102L22
TB1-08
M102K22
S11-3
M625A22
TB2-N1
M625B22
TB2-C1
M644N22N
TB1-G10
M644T22N
M644AF22N
M644AG22N
M644AN22N
M644AJ22N
M102R22
M650A22
M650B22
M102S2L
M655A22
M655B22
M102T22
M660A22
M660B22
M102U22
M665A22
M665B22
M905A22
M670A22
M670B22
M1564B22
M644AN22N
M644AM22N
M644AL22N
M644AK22N


2
M164AB22N
M105X22
M696A22 → S16-1
M164AC22N
M105Y22
M651A22 → S17-1
M164AD22N
M105Z22
M656A22 → S18-1
M164AE22N
M661A22 → S19-1
6
7
8
9
10
M585A22 → J274-U
M646A22 → S20-1
N564A22N → J274-B
M102R22
M650A22 → S16-3
M650B22 → TB2-H6
M102S22
M653A22 → S17-3
M655B22 → TB2-H7
M102T22
M660A22 → S18-3
M660B22 → TB2-H8
M102U22
M665A22 → S19-3
M665B22 → TB2-H9
M302A22 J274-A
M670A22 → S20-3
M670B22 → TB2-H10
M364D22N → J274-E
M164AN22N
M164AM22N
M164AL22N
M164AK22N
TB2-F5 ← M645B22
TB2-L5 ← M645C22
TB2-F4 ← M640B22
TB2-L4 ← M640C22
TB2-F3 ← M635B22
TB2-L3 ← M635C22
TB2-F2 ← M630B22
TB2-L2 ← M630C22
TB2-F1 ← M625B22
TB2-L1 ← M625C22
J274-BF ← M623A22
J274-BM ← M628A22
J274-AU ← M633A22
J274-AC ← M638A22
J274-AH ← M643A22
TB2-H5 ← M645C22
TB2-H4 ← M640C22
TB2-H3 ← M635C22
TB2-H2 ← M630C22
TB2-H1 ← M625C22
J274-BN ← M624A22
J274-BP ← M629A22
J274-AV ← M634A22
J274-AS ← M639A22
J274-AJ ← M644A22
J273-M ← M405A22
TB1-D4 ← M402B22
J273-A8 ← M405A22
92-R ← M403B22
J273-X ← M405A22
TB1-A6 ← M405B22



9024503-W-1

Figure 6-15. Flight Instrumentation Simulator Panel Wiring Diagram (Sheet 3 of 5)


J277-R M684A22
J277-M M682A22
J277-N M681A22
J277-P M680A22
J277-T M677A22
J277-V M676A22
J277-W M679A22
J277-AK M676A22
J277-AN M674A22
J277-AJ M675A22
M685A22 J277-S
M683A22 J277-Q
M686A22 J277-T
M687A22 J277-U
M688A22 J277-V
M689A22 J277-W
M690A22 J277-X
M691A22 J277-Y
M692A22 J277-Z
M693A22
M694A22
J274-AL M672A22
J274-AK M671A22
J274-AM M673A22
A
B
1
2
3
4
5
6
7
8
9
R1T
R2T
R3T
R4T
R5T
R6T
R7T
R8T
R9T
M744
M745
M746
J277-AU M751A22
J277-AV M752A22
J277-AT M750A22
J277-AS M749A22
J277-AR M748A22
J277-AP M747A22
J277-AX M754A22
J277-AW M753A22
J277-AY M755A22
J277-BA M757A22
J277-AZ M756A22
J277-BB M758A22
C
D
R10T
R11T
R12T
R13T
R14T
R15T
R16T
R17T
R18T
M765
M767
M766
M768
M770
M769
M773
M772
M771
M764
M763
M762
M761
M759
M760
J273-AC M776A22
J273-AD M775A22
J273-AE M774A22
J276-G M779A22
J276-F M778A22
J276-H M780A22
TB2-P10 M264A22N
TB3-F9 M820A22
M815C22
E
F
R19T
R20T
R21P
R22P
R23P
R24P
R25P
R26P
R27P
R28P
CR29P
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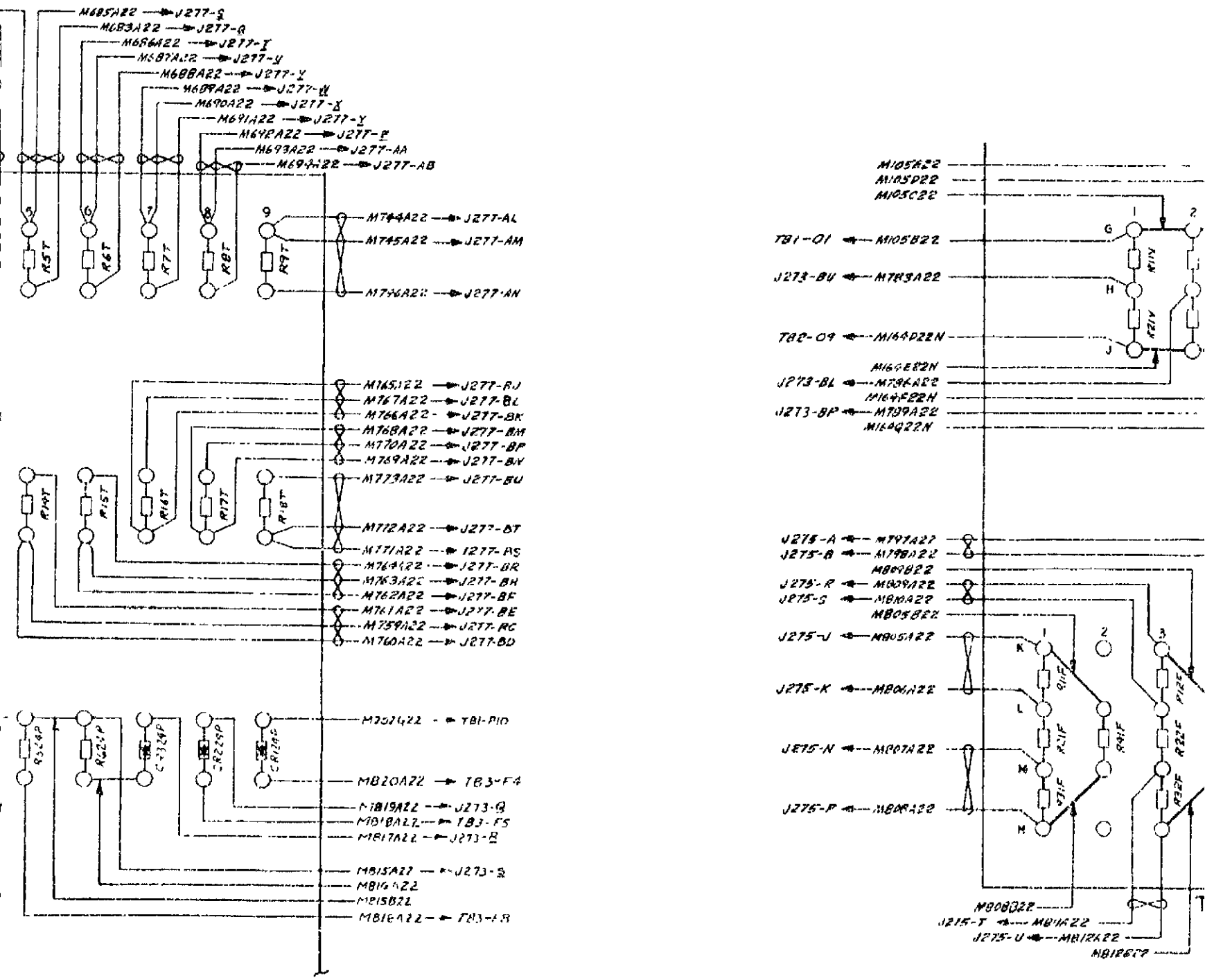
M817
M815
M816
M814


M685A22 → J277-S
M683A22 → J277-R
M686A22 → J277-T
M687A22 → J277-U
M688A22 → J277-V
M689A22 → J277-W
M690A22 → J277-X
M691A22 → J277-Y
M692A22 → J277-P
M693A22 → J277-AA
M694A22 → J277-AB
R5T
R6T
R7T
R8T
R9T
M744A22 → J277-AL
M745A22 → J277-AM
M746A22 → J277-AN
M765A22 → J277-BJ
M767A22 → J277-BL
M766A22 → J277-BK
M768A22 → J277-BM
M770A22 → J277-BP
M769A22 → J277-BN
M773A22 → J277-BU
M772A22 → J277-BT
M771A22 → J277-BS
M764A22 → J277-BR
M763A22 → J277-BH
M762A22 → J277-BF
M761A22 → J277-BE
M759A22 → J277-BC
M760A22 → J277-BD
R1ST
R2ST
R3ST
R4ST
R5ST
M802A22 → TB1-P10
MB20A22 → TB3-F4
MB19A22 → J273-G
MB18A22 → TB3-F5
MB17A22 → J273-B
MB15A22 → J273-S
MB16A22 → TB3-F8
M1057A22
M1058P22
M1059C22
TB1-01 ← M1058B22
J273-BV ← M783A22
TB2-09 ← M1660P22N
M1662E22N
J273-BL ← M784A22
M1664F22N
J273-BP ← M799A22
M1668Q22N
J275-A ← M797A22
J275-B ← M798A22
M807B22
J275-R ← M809A22
J275-S ← M810A22
M805B22
J275-J ← M805A22
J275-K ← M806A22
J275-N ← M807A22
J275-P ← M808A22
M808D22
J275-T ← MB11A22
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MB12E22

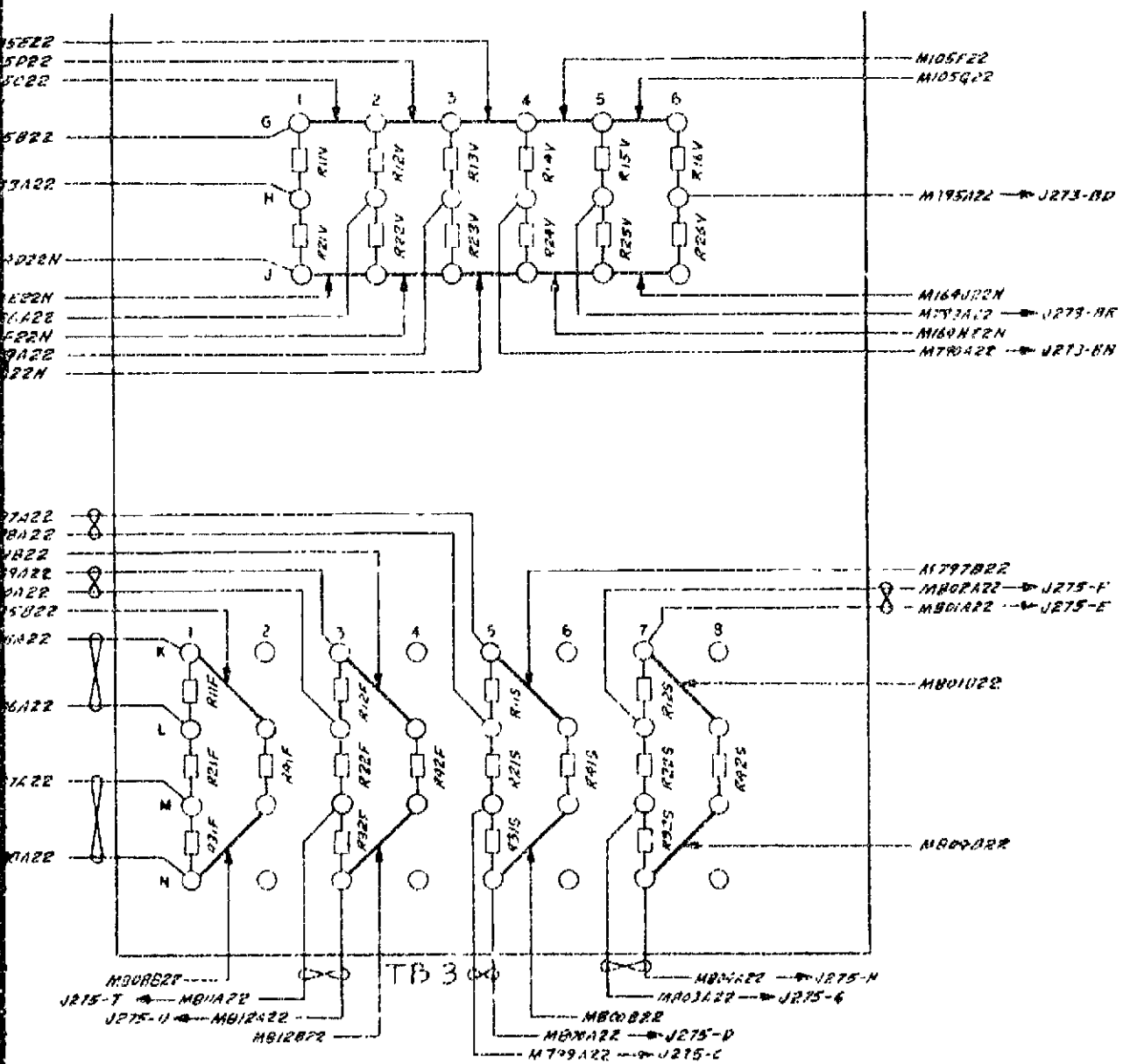
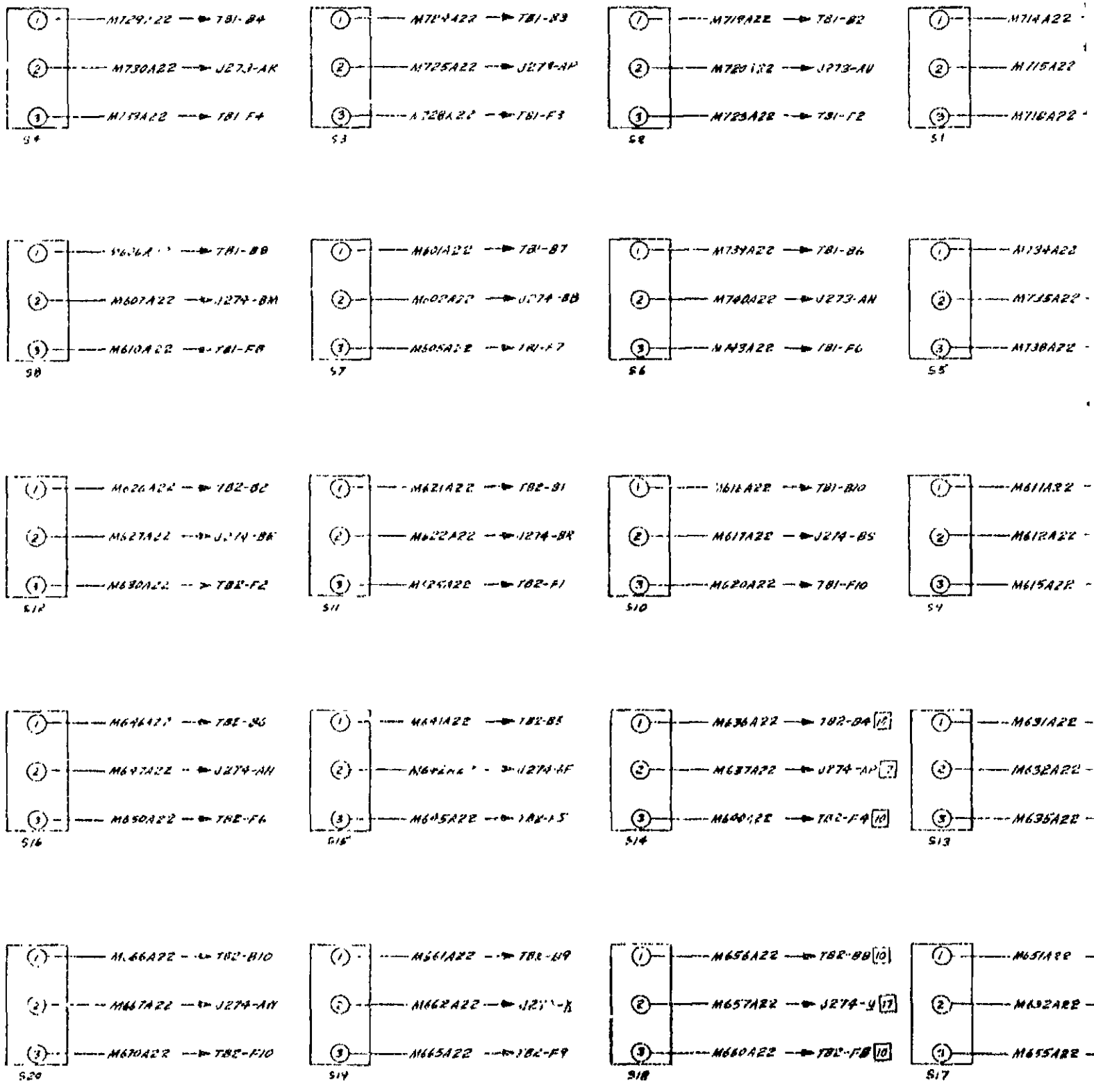


Figure 6-15. Flight Instrumentation Simulator Panel Wiring Diagram (Sheet 4 of 5)


1
2
3
M729A22 → TB1-B4
M730A22 → J273-AK
M731A22 → TB1-F4
S4
M724A22 → TB1-B3
M725A22 → J274-AP
M726A22 → TB1-F3
S3
M718A22 → TB1-B2
M729A22 → J273-AV
M723A22 → TB1-F2
S2
M714A22
M715A22
M716A22
S1
M606A22 → TB1-B8
M607A22 → J274-BM
M610A22 → TB1-F8
S8
M601A22 → TB1-B7
M602A22 → J274-BB
M605A22 → TB1-F7
S7
M739A22 → TB1-B6
M740A22 → J273-AN
M743A22 → TB1-F6
S6
M734A22
M735A22
M738A22
S5
M626A22 → TB2-B2
M627A22 → J274-BK
M630A22 → TB2-F2
S12
M621A22 → TB2-B1
M622A22 → J274-BR
M625A22 → TB2-F1
S11
M612A22 → TB1-B10
M617A22 → J274-BS
M620A22 → TB1-F10
S10
M611A22
M612A22
M615A22
S9
M646A22 → TB2-B5
M647A22 → J274-AN
M650A22 → TB2-F4
S16
M641A22 → TB2-B5
M642A22 → J274-AF
M645A22 → TB2-F5
S15
M636A22 → TB2-B4 12
M637A22 → J274-AP 7
M640A22 → TB2-F4 10
S14
M631A22
M632A22
M635A22
S13
M656A22 → TB2-B10
M657A22 → J274-AN
M660A22 → TB2-F10
S20
M651A22 → TB2-B9
M652A22 → J274-AK
M655A22 → TB2-F9
S19
M656A22 → TB2-B8 10
M657A22 → J274-AJ 17
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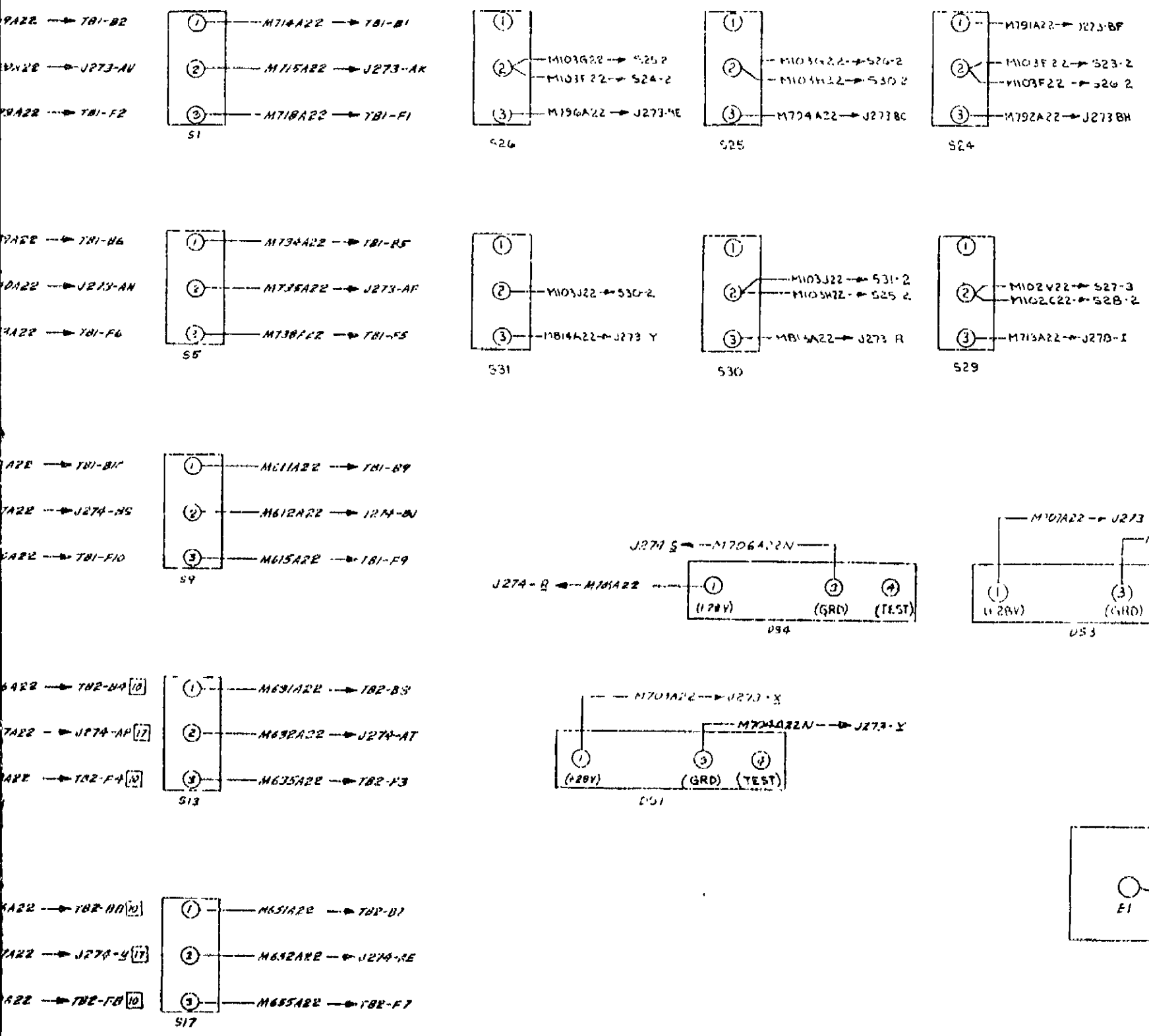
M652A22
M655A22
S17


M714A22 → TB1-B1
M715A22 → J273-AK
M718A22 → TB1-F1
S1
M1034G22 → S25-2
M1035F22 → S24-2
M796A22 → J273-NE
S26
M1036G22 → S26-2
M1034H22 → S30-2
M794A22 → J273-BC
S25
M791A22 → J273-BF
M1035F22 → S23-2
M1035F22 → S26-2
M792A22 → J273-BH
S24
M734A22 → TB1-B5
M735A22 → J273-AF
M738F22 → TB1-F5
S5
M1033J22 → S30-2
M1814A22 → J273-Y
S31
M1033J22 → S31-2
M1035W22 → S25-2
M1814A22 → J273-R
S30
M1032V22 → S27-3
M1032C22 → S28-2
M713A22 → J270-I
S29
M611A22 → TB1-B9
M612A22 → J274-BJ
M615A22 → TB1-F9
S9
J274-S → M706A22N
J274-R → M616A22
(+28V)
(GRD)
(TEST)
D94
M707A22 → J273-X
M708A22N → J273-Y
(+28V)
(GRD)
(TEST)
D51
M631A22 → TB2-B3
M632A22 → J274-AT
M635A22 → TB2-F3
S13
M651A22 → TB2-D7
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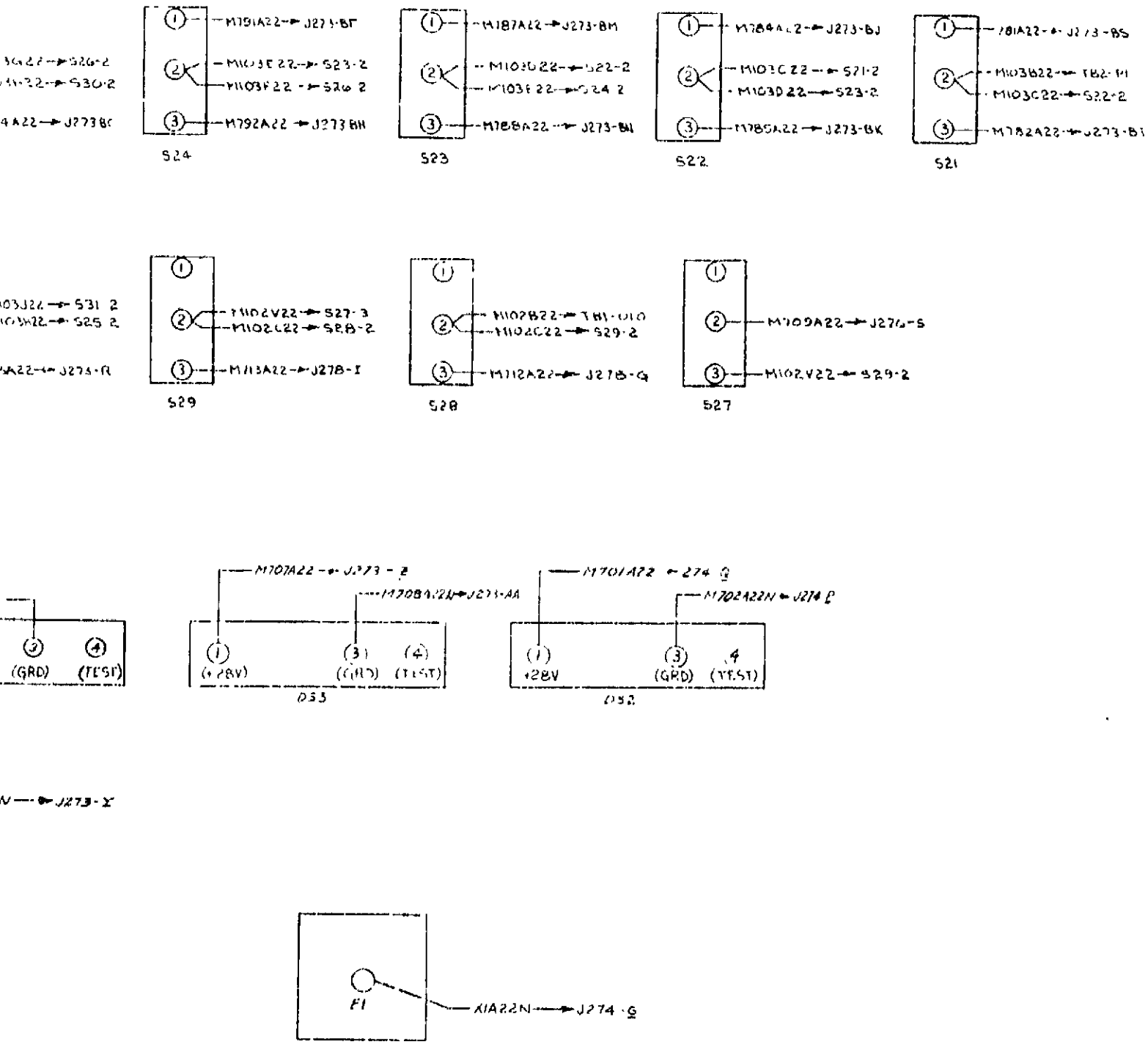
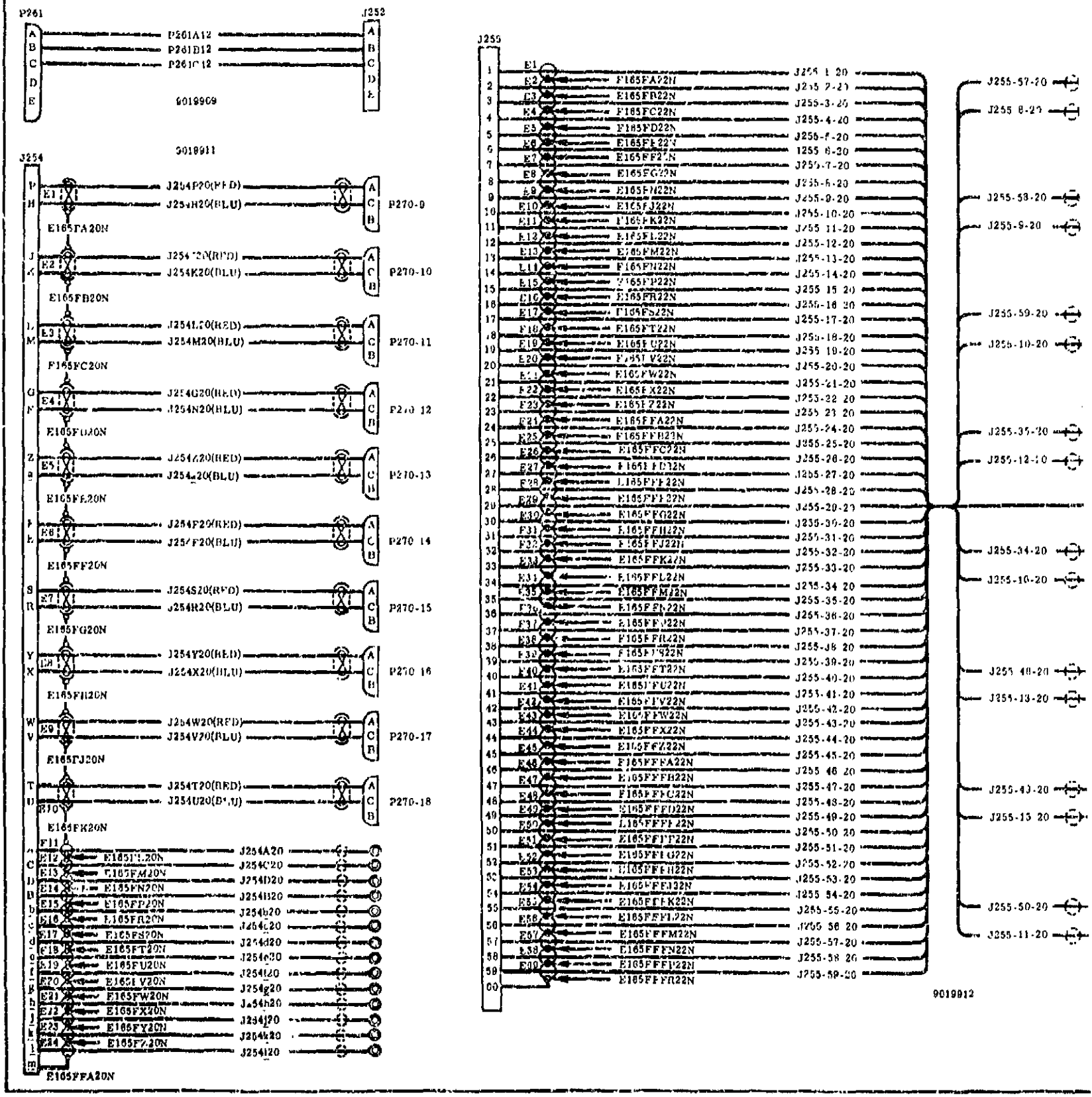
M655A22 → TB2-F7
S17
E1



9324503-W.

Figure 6-15. Flight Instrumentation Simulator Panel Wiring Diagram (Sheet 5 of 5)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P261B12
P261C12
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9019911
J254
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J254H20(BLU)
E165FA20N
P270-9
J254R20(RED)
J254K20(BLU)
E165FB20N
P270-10
J254L20(RED)
J254M20(BLU)
F165FC20N
P270-11
J254G20(RED)
J254N20(BLU)
E165FD20N
P270-12
J254Z20(RED)
J254a20(BLU)
E165FE20N
P270-13
J254F20(RED)
J254P20(BLU)
E165FF20N
P270-14
J254S20(RED)
J254R20(BLU)
E165FG20N
P270-15
J254Y20(RED)
J254X20(BLU)
E165FH20N
P270-16
J254W20(RED)
J254V20(BLU)
E165FJ20N
P270-17
J254T20(RED)
J254U20(BLU)
E165FK20N
P270-18
J254A20
J254C20
J254D20
J254B20
J254b20
J254c20
J254d20
J254e20
J254f20
J254g20
J254h20
J254j20
J254k20
J254l20
E165FA20N
J255
E165FA22N
E165FB22N
E165FC22N
E165FD22N
E165FE22N
E165FF22N
E165FG22N
E165FH22N
E165FJ22N
E165FK22N
E165FL22N
E165FM22N
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E165FV22N
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E165FZ22N
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E165FFB22N
E165FFC22N
E165FFD22N
E165FFE22N
E165FFF22N
E165FFG22N
E165FFH22N
E165FFJ22N
E165FFK22N
E165FFL22N
E165FFM22N
E165FFN22N
E165FFP22N
E165FFR22N
E165FFS22N
E165FFT22N
E165FFU22N
E165FFV22N
E165FFW22N
E165FFX22N
E165FFY22N
E165FFZ22N
E165FFA22N
E165FFB22N
E165FFC22N
E165FFD22N
E165FFE22N
E165FFF22N
E165FFG22N
E165FFH22N
E165FFJ22N
E165FFK22N
E165FFL22N
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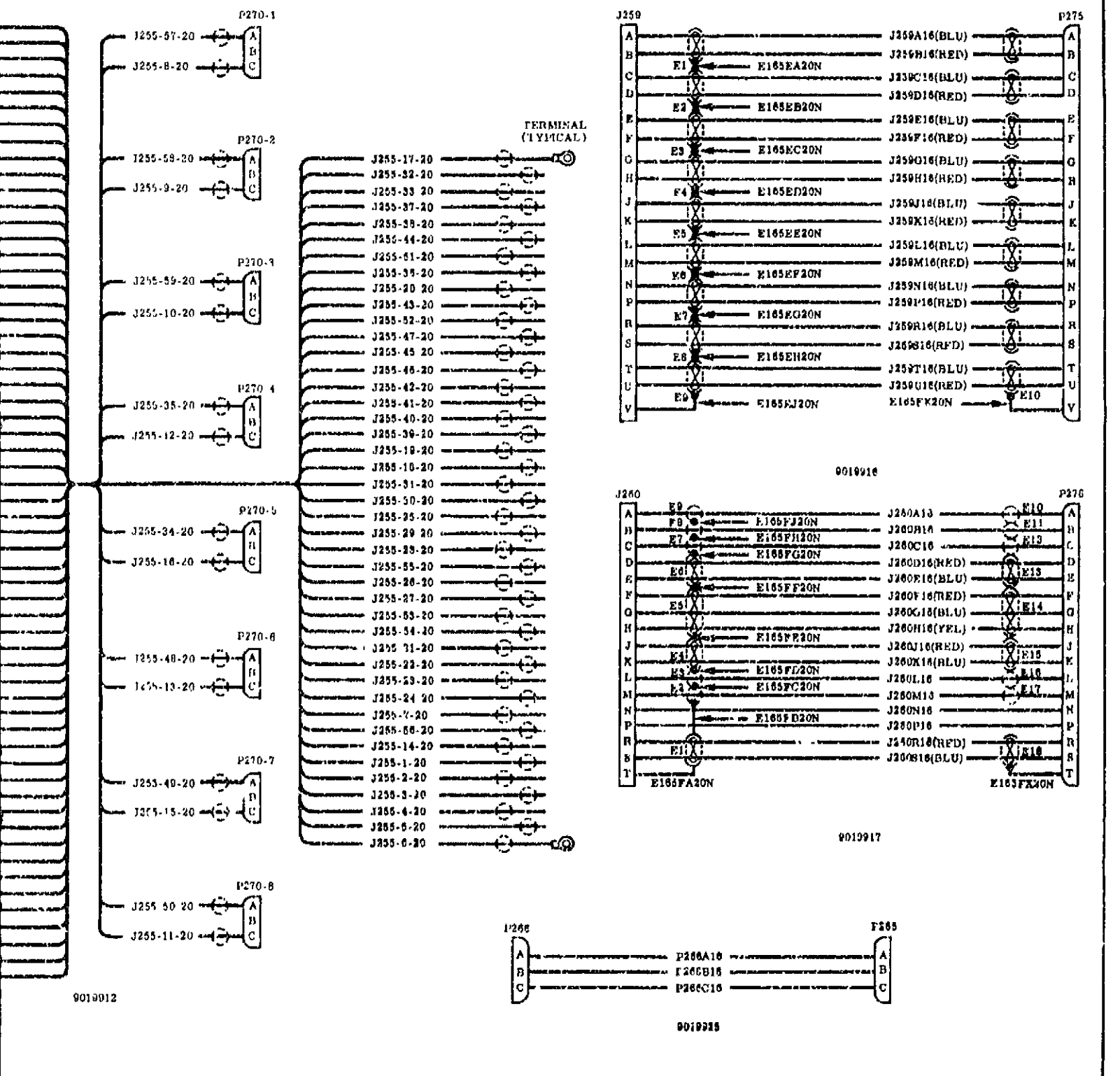
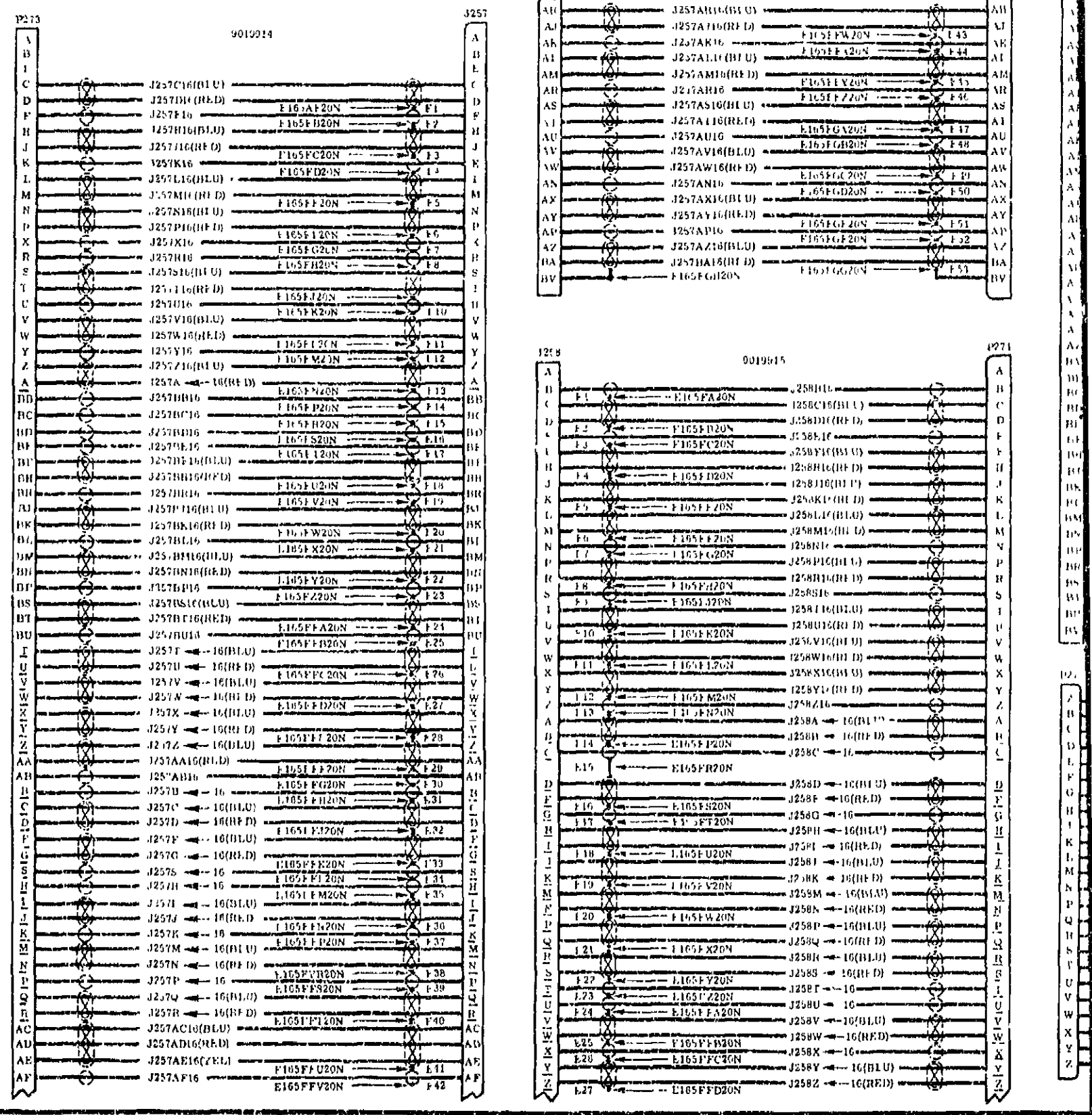


Figure 6-16. Internal Electrical Cable Wiring Diagram (Sheet 1 of 2)


P273
J257
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J257U16
J257V16(BLU)
J257W16(RED)
J257Y16
J257Z16(BLU)
J257A16(RED)
J257BB16
J257BC16
J257BD16
J257BE16
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J257BH16(RED)
J257BJ16
J257BK16(RED)
J257BL16
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J257P 16
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E165FT20N
E165FU20N
E165FV20N
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E165FB20N
E165FC20N
E165FD20N
E165FF20N
E165FE20N
E165FG20N
E165FH20N
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E165FK20N
E165FL20N
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E165FR20N
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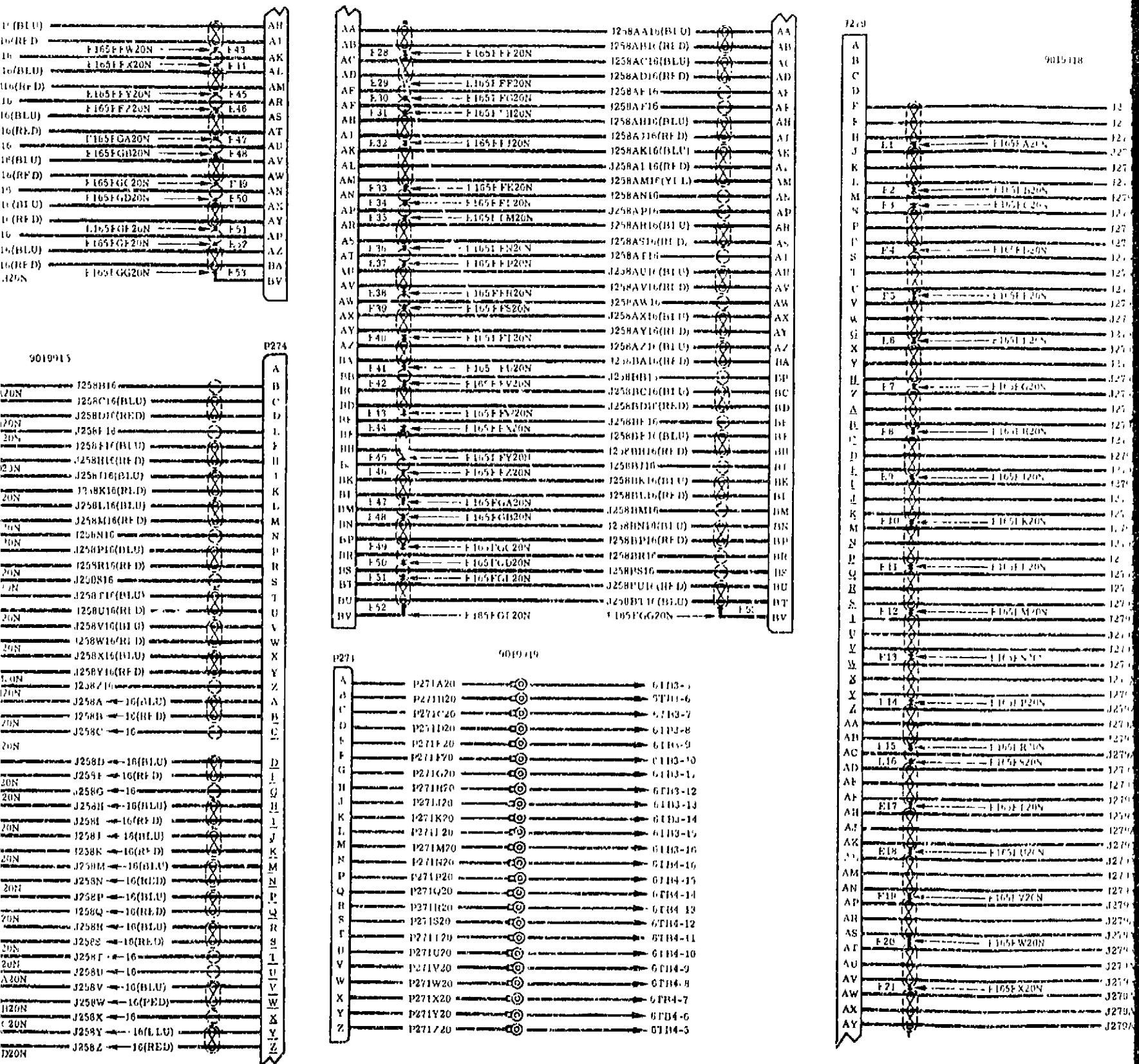

Figure 6-

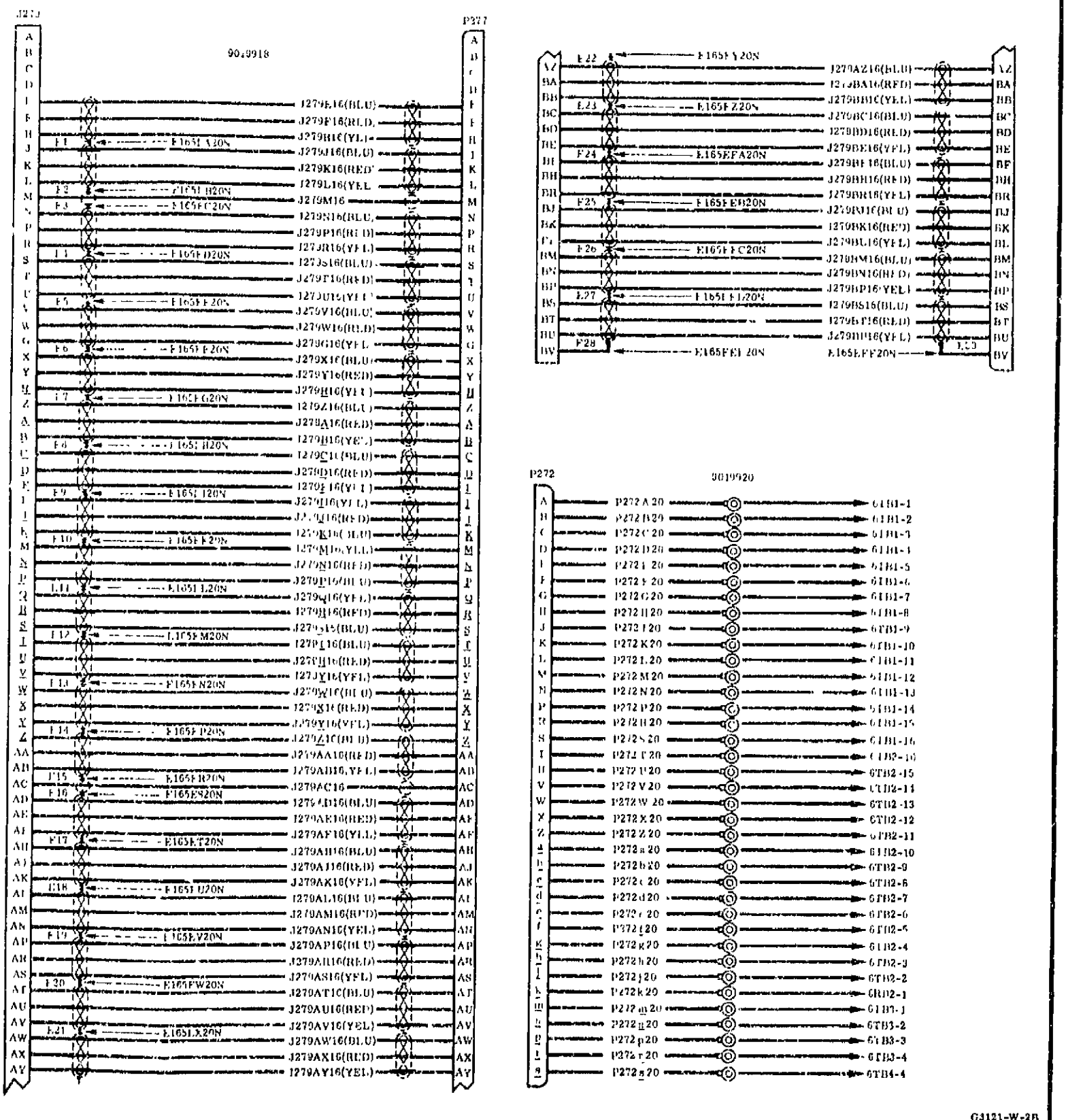

Figure 6-16. Internal Electrical Cable Wiring Diagram (Sheet 2 of 2)

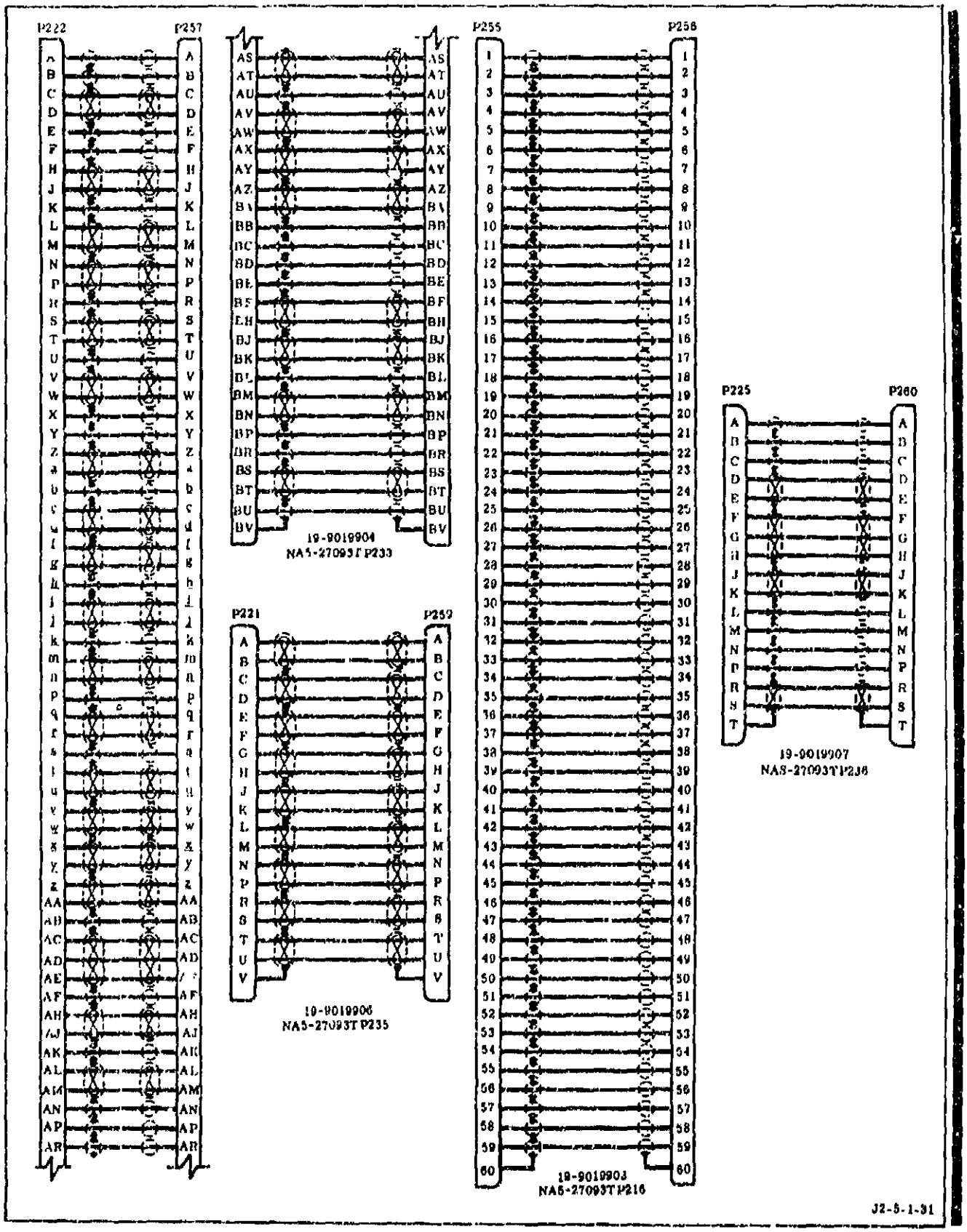

Figure 6-17. External Electrical Cable Wiring Diagrams (Sheet 1 of 2)

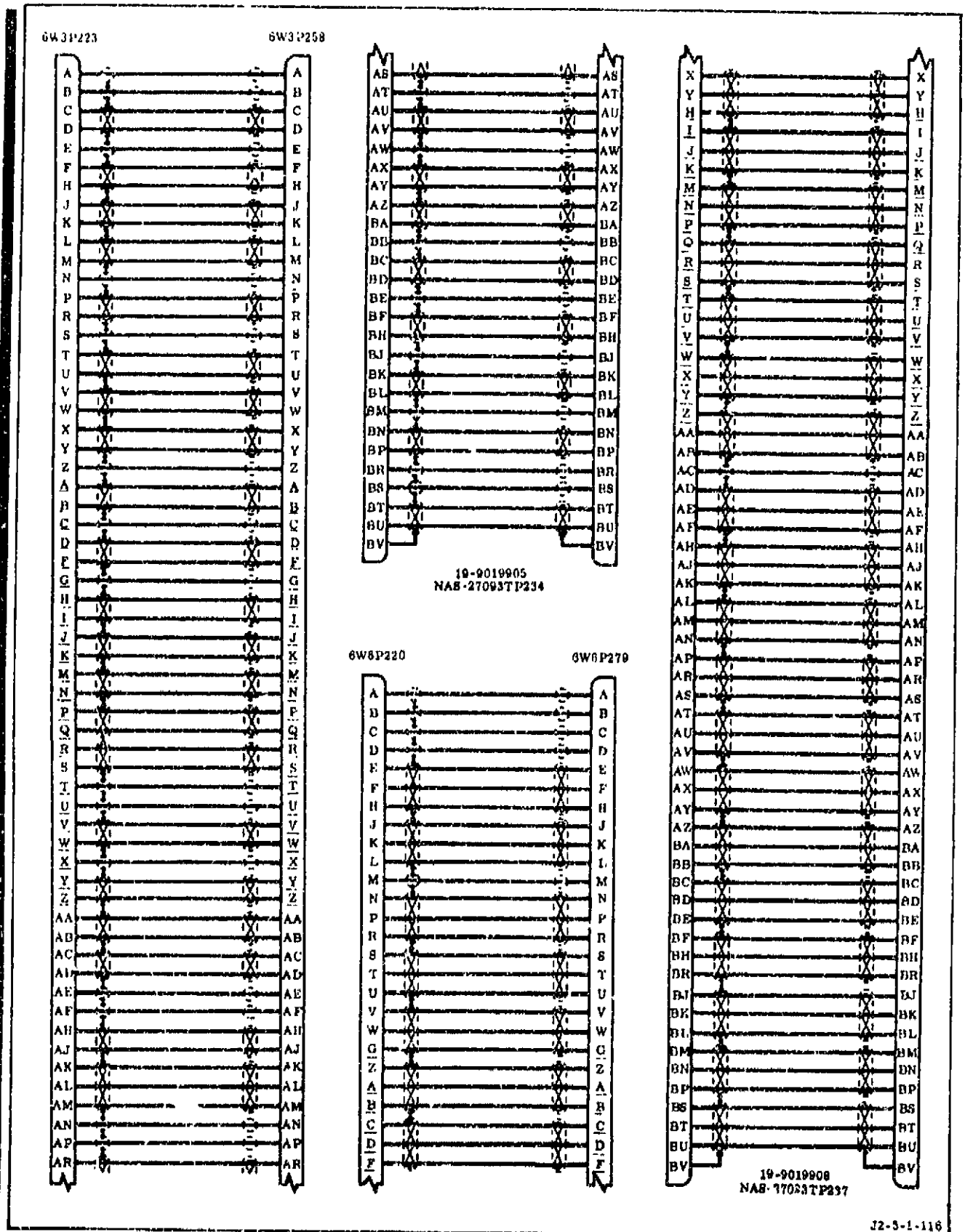

Figure 6-17. External Electrical Cable Wiring Diagrams (Sheet 2 of 2)

6-31. LOADING EVENT RECORDER.

6-32. Load the event recorder (figure 6-5) with chart paper, E-60 m (Technirite Electronics Inc) as follows:

a. Disengage CHART RELEASE LEVER by depressing lever.

b. Raise recorder writing table and remove chart paper spool from recorder.

c. Remove paper core from spool.

d. Square end of a full roll of chart paper by tapping on a flat surface.

e. Hold roll of chart paper so that paper unwinds from the bottom and position roll with squared end facing spool flange.

f. Insert chart paper spool through core until squared end of chart paper is flush with spool flange.

g. Unwind approximately 3 feet of paper and cut approximately 8 inches of leading edges in a tapered form.

h. Lift and hold writing table. Install spool on brackets by pushing spool back and down against paper tension arm until spool is seated.

i. Ensure that slack does not exist between chart paper and paper tension arm, since this may cause paper to drift.

j. Thread chart paper over edge of writing table and, while pulling on chart paper, close writing table.

CAUTION

Chart paper must be carefully threaded over the edge of writing table to avoid damaging styli.

k. Thread chart paper between 3 idler rollers and main drive roller.

l. Tighten chart paper against writing table and release CHART RELEASE LEVER engaging friction drive.

m. Thread chart paper onto bottom rewinder; aline edges of paper and tape paper to paper core on rewinder.

n. Turn rewinder by hand until slack is removed.

6-33. POSITIONING EVENT RECORDER CHART PAPER.

6-34. To compensate for slight dimensional changes in paper and variations in paper width, the chart paper can be adjusted laterally approximately 1/8-inch by using the CHART POSITIONER. Position the chart paper as follows:

a. Move POWER switch on EVENT RECORDER to ON.

b. Rotate CHART SPEEDS switch to 125 and allow 8-10 feet of chart paper to run through recorder. Turn CHART SPEEDS switch to OFF.

c. Check styli for proper alinement to printed chart paper.

d. Rotate CHART SPEEDS switch to .05, run 8-10 feet of chart paper, and observe the trace. Trace must be between limit lines of unprinted portion (right-hand when facing event recorder) of respective channel. Rotate CHART POSITIONER lever upward to adjust chart paper to the left (when facing event recorder) and downward to adjust chart paper to the right.

NOTE

The reaction time of chart positioner is rather slow.
Allow several feet of paper to run after each adjustment.

e. Rotate CHART SPEEDS switch to 5. Move TIMER switch to ON. Ensure that timing pips on channel 60 are two small divisions apart.

f. Turn CHART SPEEDS switch to OFF. Move TIMER switch to OFF.

6-35. LOADING RECORDING OSCILLOGRAPH.

6-36. To load oscillograph (figure 6-6) with recording paper, proceed as follows:

a. Pivot idler rod forward.

b. Simultaneously pull pinch roller releases and remove pinch roller.

c. Lower paper transport housing.

d. Insert roll of recording paper so that paper feeds from bottom of roll with emulsion side up.

e. Thread paper over metering roller and pull out 14-16 inches of paper. Close transport housing.

f. Replace pinch roller, ensuring that releases are firmly seated.

g. Replace idler rod and route paper over idler rod, under roller, over spacer rod, and under paper core, with the emulsion side facing down.

h. Move TAKE UP REEL switch to ON. Move POWER switch to ON. Depress red ON-OFF and 16 pushbuttons. Recording paper must run through oscillograph.

i. Depress red ON-OFF button and move POWER and TAKE UP REEL switches to OFF.

6-37. LUBRICATING EVENT RECORDER.

6-38. The lubrication requirements for event recorder are listed in figure 6-18.

Lubricant Point	Lubricant	Amount
Top and bottom bearing, electromagnetic pivot shaft.	Mix 50 parts of machine oil (SAE-10) with 50 parts of Molykote, type G, Lubricant (Alpha-Molykote Corp).	2 drops
Rewind chain and bearings.	Mix 50 parts of machine oil (SAE-10) with 50 parts of Molykote, type G, Lubricant (Alpha-Molykote Corp).	Sparingly (wipe off excess)
Six shafts protruding through drive transmission side plates.	Machine oil (SAE-10).	1 drop
Motor drives.	Machine oil (SAE-10).	2 drops

Figure 6-18. Lubrication Requirements for Event Recorder

6-39. CLEANING ELECTRICAL PANELS.

6-40. Gain access to panels through console rear access door. Remove dirt, dust, and foreign matter from panel components and circuitry, using low-pressure (10 psig maximum) gaseous nitrogen (MIL-P-27401) or a vacuum cleaner.

WARNING

Flying particles loosened and propelled by gaseous nitrogen can cause injury to personnel.

SECTION VII

ENGINE TEST PLATES, ADAPTERS, AND TOOLS

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

9016701, Bypass Duct Test Plate Kit
9016710, Hot-Gas Exhaust Test Plate Kit
9016711-21, Fuel Turbine Torquing Wrench Kit
9016712-11, Oxidizer Turbine Accessory Drive Torquing Wrench Kit
9016713, Turbopump Inlet Duct Test Plate Kit
9016719, 30 PSIG Customer Connection 1-Inch Test Plate Kit
9016723-11, Bypass Valve Actuation Plate Kit
9016724, 250 PSIG Customer Connection 5/8 Inch Test Plate Kit
9017259, Oxidizer Turbine Accessory Drive Shaft Torquing Wrench Kit
9017273, 500 PSIG Customer Connection 5/8 Inch Test Plate Kit
9017274, 2000 PSIG Customer Connection 5/8 Inch Test Plate Kit
9018840, 30 PSIG Customer Connection 1-1/2 Inch Test Plate Kit
9018843-11, 80 PSIG Customer Connection 5/8 Inch Test Plate Kit
9018846, Turbine Exhaust Leak-Test Plate Kit
9019960, Accumulator Hose Plate Kit
9019968, Heat Exchanger Oxidizer Supply Line Test Plate Kit
9019969, Gas Generator Control Valve Test Plate Kit
9019975, Oxidizer Dome Purge Adapter Kit
9020266, Customer Connection Oxidizer Tank Pressurization Test Plate Kit
9020269, Bypass Valve Removal Toolkit
9020784-11, Oxidizer Dome Purge Shutoff Plug Kit
9024496, Oxidizer and Fuel Turbine Drain Line Test Adapter Kit
9024497, Augmented Spark Igniter and Gas Generator Oxidizer Purge Line Test Plate Kit
9024718, Metering Valve Kit
9024994, Insulator Installer Toolkit
9024997, Thrust Chamber Start Tank Refill Flange Test Plate Kit
9024998, Gas Generator Equalization Line Leak-Test Adapter Kit
9024999, Flight Instrumentation Pressure Transducer Removal Toolkit
9025400, Pressure-Actuated Purge Valve Test Plate Kit
9025405, Calibration Pressure Switch Test Adapter Kit
9025419, Fuel Pump Leak and Flow Adapter Kit
9025591, Resistance Test Adapter Kit
9025817, Oxidizer Turbopump Seal Cavity Drain Line Test Adapter Kit
9025826, Start Tank System Drying Manifold Kit

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Underlined titles denote primary paragraphs.

7-1. DESCRIPTION AND LEADING PARTICULARS OF ENGINE TEST PLATES, ADAPTERS, AND TOOLS.

7-2. Engine test plates, adapters, plugs, tools, and torque wrenches are provided in kits, and each kit or related group of kits, is described in one of the paragraphs 7-4 through 7-27D.

7-3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY. Modifications incorporated in this manual that change the configuration or add an engine test plate, adapter, or toolkit are listed in figure 7-2

Approved ECP No.	Part No.	Incorporated in Manual Dated
J2-150	9016723-11	21 September 1965
J2-222	9018843-11	21 September 1965
J2-374	9020784-11	21 September 1965
J2-447	9016711-21	17 February 1966

Figure 7-2. Configuration Changes--Manual Effectivity

7-4. TEST PLATE KITS 9016724, 9017273, 9017274, AND 9018843-11. (See figure 7-3.) Each test plate kit consists of a container, test plate, and attaching hardware. The test plate that connects to a customer-connect flange is equipped with an inlet fitting for pressurizing and a burst diaphragm for protecting the system from overpressurization. Individual test plates are not interchangeable, due to location of flange alinement pins and different pressure ratings of burst diaphragms. The 5/8-inch, 600-psig customer-connection test plate kit 9016724 consists of container VD192-0002-0844, plate assembly 9020223, 6 bolts AN4-17A, 12 washers LD153-0010-0009, 6 nuts NAS679A4W, and packing MS29513-019. Plate assembly 9020223 has a maximum operating pressure of 250 psig and a burst diaphragm rated at 400 psig. The 5/8-inch, 500-psig customer-connection test plate kit 9017273 consists of container VD192-0002-0844, plate assembly 9020274, 6 bolts AN4-17A, 12 washers LD153-0010-0009, 6 nuts NAS679A4W, and packing MS29513-019. The plate assembly 9020274 has a maximum operating pressure of 500 psig and a burst diaphragm rated at 750 psig. The 5/8 inch, 2,000-psig customer-connection test plate kit 9017274 consists of container VD192-0002-0844, plate assembly 9020275, 6 bolts AN4-17A, 12 washers LD153-0010-0009, 6 nuts NAS679A4W, and packing MS29513-019. Plate assembly 9020275 has a maximum operating pressure of 2,000 psig and a burst diaphragm rated at 3,000 psig. The 5/8-inch, 30-psig customer-connection test plate kit 9018843-11 includes plate assembly 9020222-11, container VD192-0002-0844, 6 bolts AN4-17A, 12 washers LD153-0010-0009, 6 nuts NAS679A4W, and packing MS29513-019. Plate assembly 9020222-11 has a maximum operating pressure of 80 psig and a burst diaphragm rated at 120 psig.

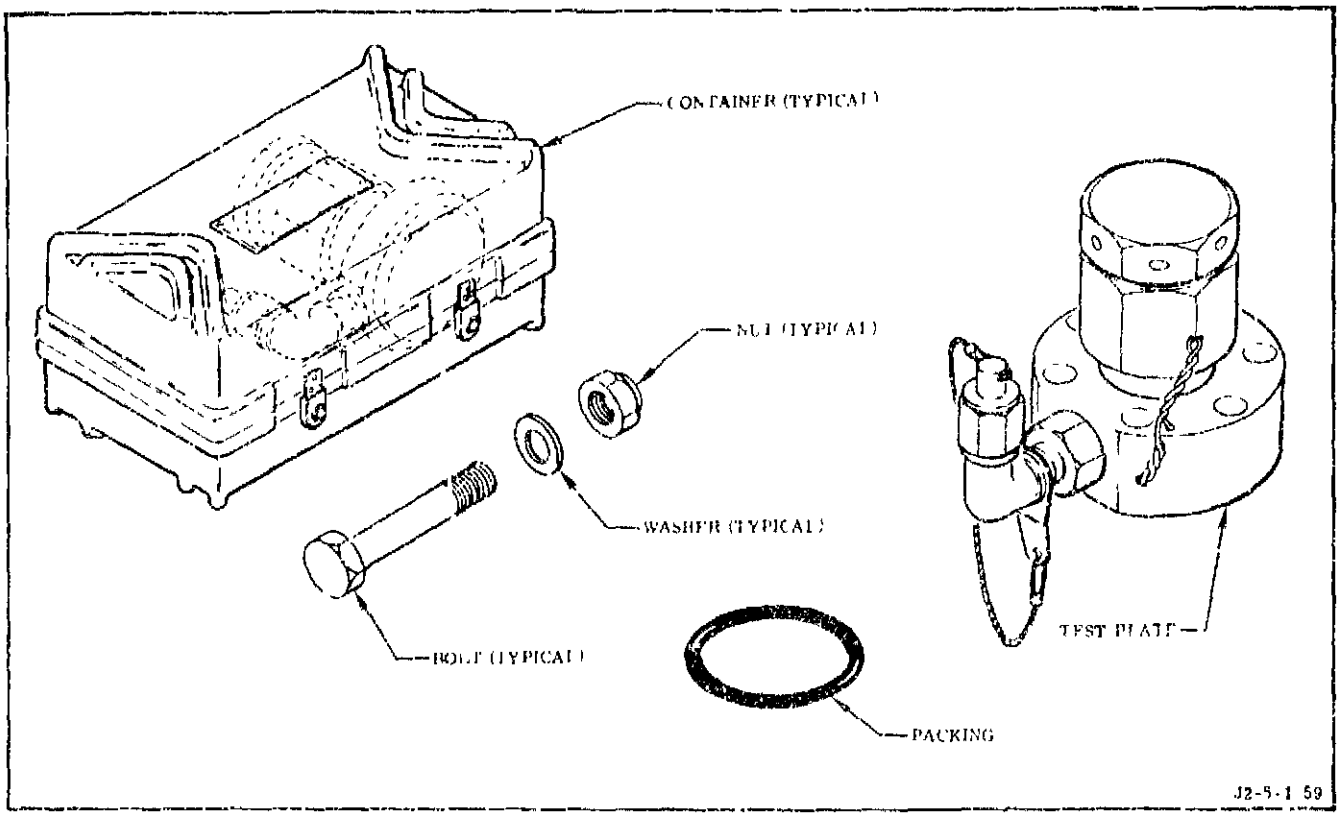

Figure 7-3. Test Plate Kits 9016724, 9017273, 9017274, and 9018843-11

7-5. TEST PLATE KITS 9016719, 9018840, AND 9020266. (See figure 7-4.) Each test plate kit consists of a container, a test plate, and attaching hardware. The test plate assembly connects to customer-connect flange and is equipped with an inlet fitting for pressurizing and a burst diaphragm that protects the system from overpressurization. Each test plate assembly has a maximum operating pressure of 30 psig and a burst diaphragm rated at 50 psig. The one-inch, 30 psig customer-connection test plate kit 9016719 consists of container VD192-0002-0844, plate assembly 9016746, 6 bolts AN4-24A, 12 washers LD153-0010-0009, 6 nuts NAS679A4W, and packing MS29513-026. The 1-1/2 incl, 30-psig customer-connection test plate kit 9018840 consists of container VD192-0002-0844, plate assembly 9020526, 8 bolts AN4-24A, 8 washers LD153-0010-0009, 8 nuts NAS679A4W, and packing MS29513-133. Oxidizer tank pressurizing customer-connection test plate kit 9020266 consists of container VD192-0002-0844, plate assembly 9020528, 8 bolts AN4-24, 8 washers LD153-0010 0009, 8 nuts NAS679A4W, and/packing MS29513-133.

7-6. AUGMENTED SPARK IGNITER AND GAS GENERATOR OXIDIZER PURGE LINE TEST PLATE KIT 9024497. (See figure 7-5.) Augmented spark igniter and gas generator oxidizer purge line test plate kit 9024497 consists of container VD192-0008-0015, 2 test plate assemblies 9025370, 8 bolts AN3 7A, 16 washers LD155-0010-0007, 3 nuts NAS679A3W, and 2 packings AN6227-11. Each test plate assembly has a maximum operating pressure of 400 psig and a burst diaphragm rated at 800 psig. The test plate assemblies are connected to the downstream flange of the augmented spark igniter and gas generator oxidizer purge lines. This kit is used while performing the reverse-flow leak test of the augmented spark igniter oxidizer purge check valve and the gas generator oxidizer cavity purge check valve.

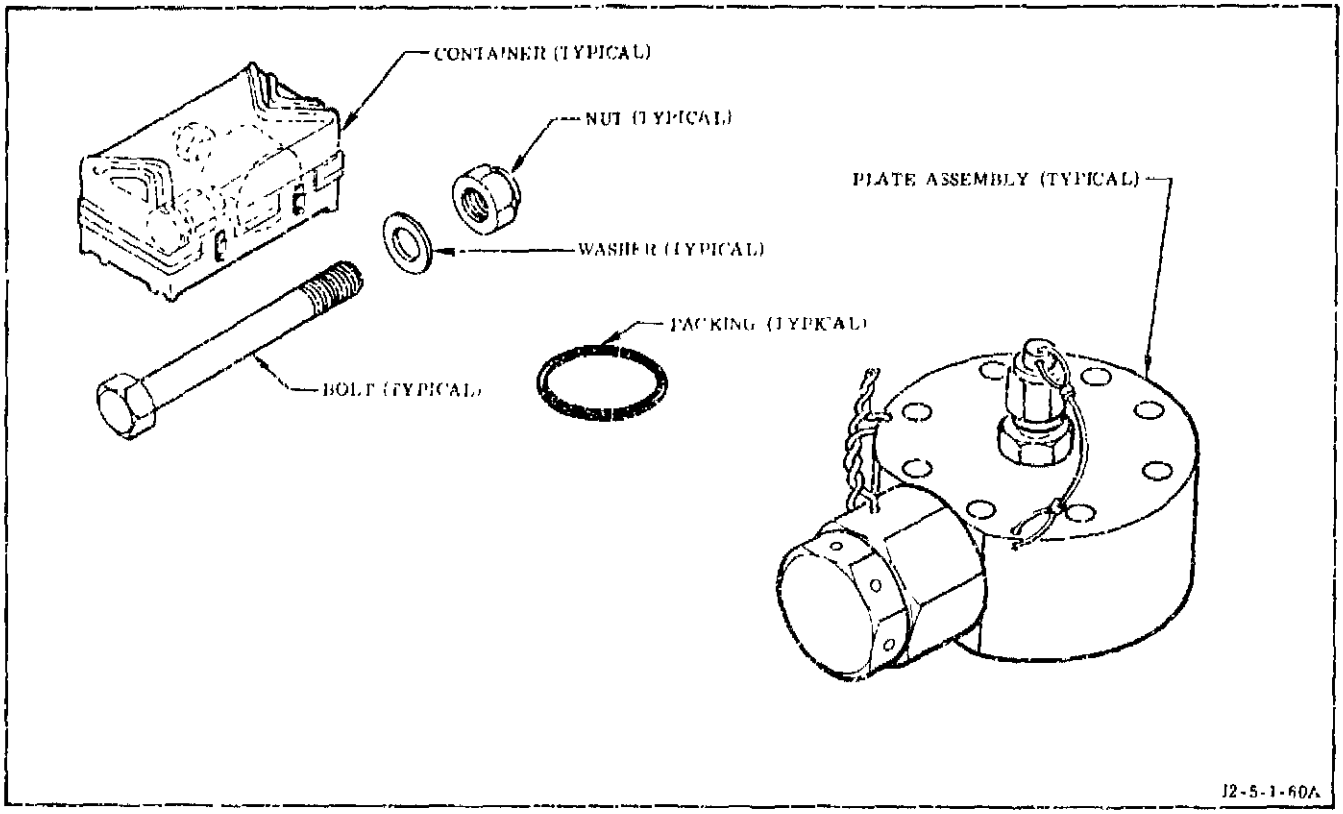

Figure 7-4. Test Plate Kits 9016719, 9018340, and 9020266

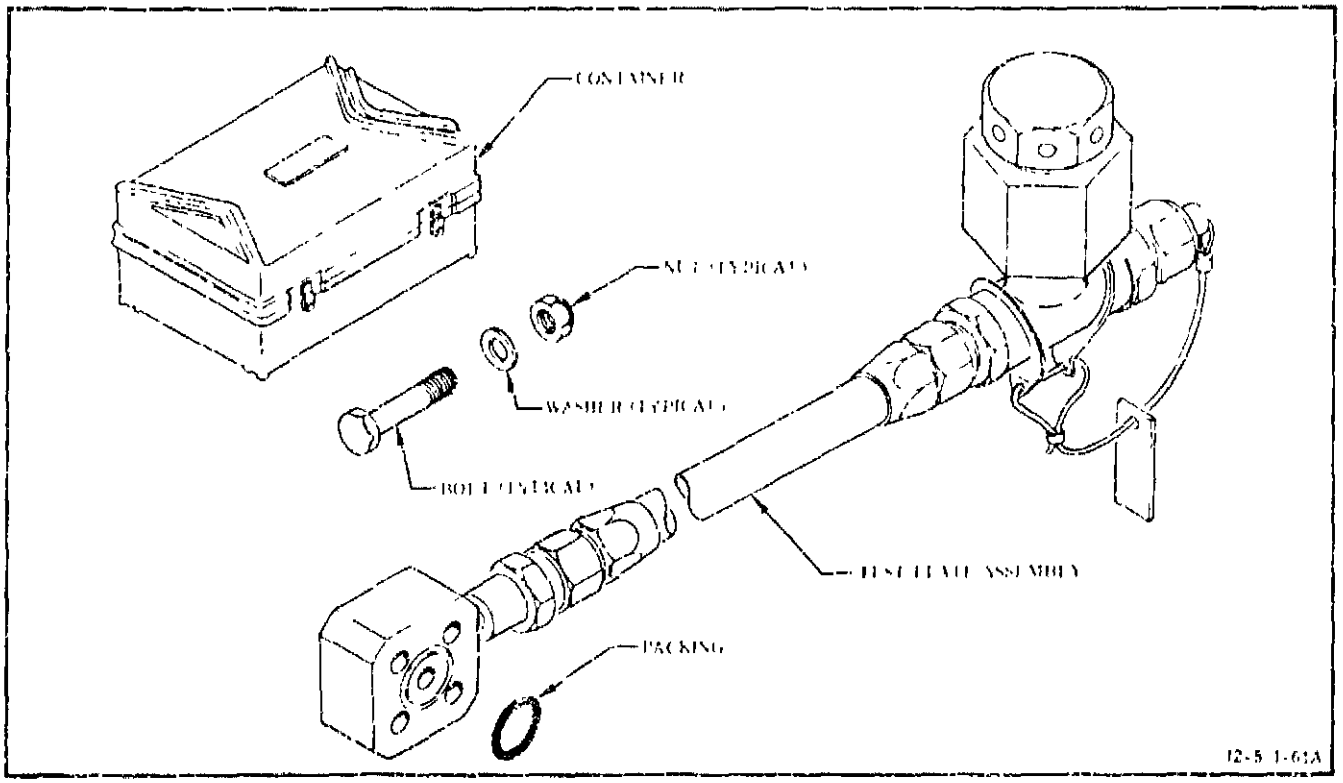

Figure 7-5. Augmented Spark Igniter and Gas Generator Oxidizer Purge Line Test Plate Kit 9024497

7-7. TURBINE EXHAUST SYSTEM LEAK-TEST PLATE KIT 9018846. (See figure 7-6.) Turbine exhaust leak-test plate kit 9018846 consists of container VD192-0008-0015, plate 9020213, and adapter assembly 9022823. The adapter has a pressurizing and monitoring port and a burst diaphragm rated at 50 psig. The maximum operating pressure of the adapter and the plate is 30 psig. The adapter is used to supply and monitor pressures in the engine exhaust system and is connected at the fuel turbopump torque access for leak-test procedures. The test plate is a metal plate with a Teflon gasket on one face and is used on the accessory drive pad mounting flange when the engine exhaust plate is not installed.

7-8. BYPASS VALVE ACTUATION PLATE KIT 9016723-11. (See figure 7-7.) Bypass valve actuation plate kit 9016723-11 includes plate assembly 9020251-11, container VD192-0002-0844, 4 bolts AN4-15A, and 4 washers LD153-0011-0013. The plate assembly has a manual bleed valve and a check valve with a maximum operating pressure of 400 psig. The plate assembly seals the actuator closing port of the oxidizer turbine bypass and provides a connect point for a pressure source.

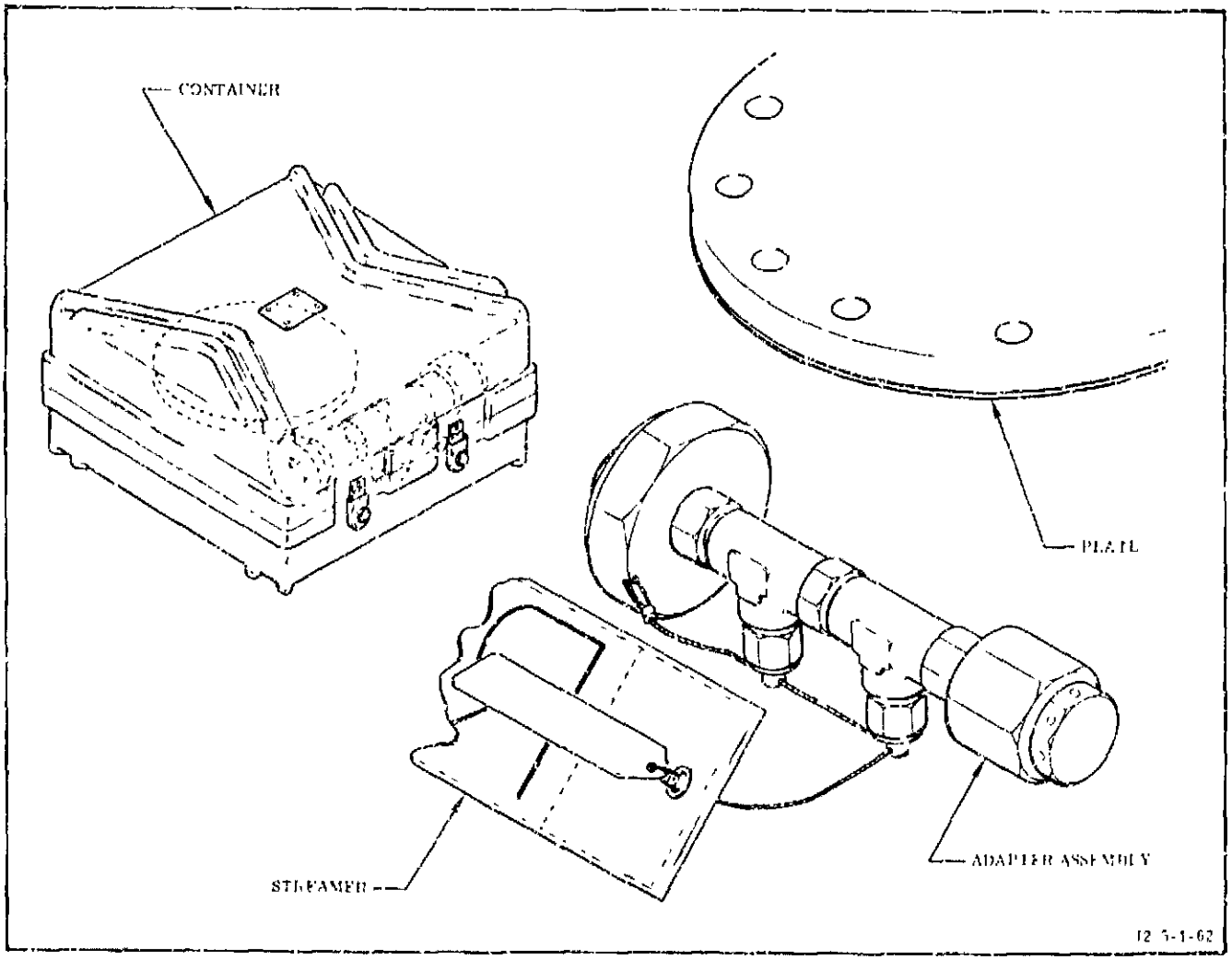

Figure 7-6. Turbine Exhaust System Leak-Test Plate Kit 9016846

7-9. BYPASS DUCT TEST PLATE KIT 9016701 AND 9016701-11. (See figure 7-8.) The bypass duct test plate kit 9016701 consists of container VC192-0002-0884 and bypass duct test plate 9020225. Bypass duct test plate kit 9016701-11 consists of container VD192-0002-0884, bypass duct test plate 9020225, 8 bolts RD111-1009-0440, 8 washers LD153-0013-0002, 8 washers RD153-1002-0004, and 8 nuts RD114-1002-0004. The test plate is a metal plate with a flat Teflon or rubber seal on each face. The test plate is inserted between the flange of the bypass valve and the turbine exhaust duct flange during leak tests. The maximum operating pressure is 30 psig.

7-10. HOT GAS EXHAUST TEST PLATE KIT 9016710 AND 9016710-11. (See figure 7-8.) Hot-gas exhaust test plate kit 9016710 consists of container VD192-0008-0015 and test plate 9019860-11. Hot-gas exhaust test plate kit 9016710-11 consists of container VD192-0008-0015, test plate 9019860-11, 10 bolts RD111-1009-3426, 10 washers LD153-0013-0002, and 10 nuts RD114-1002-0004. The metal test plate is approximately 14 inches in diameter, with 2 rubber seals (one for each face) that provide sealing capability. The test plate is installed between the heat exchanger and the exhaust manifold flange during engine system leak tests. The maximum operating pressure is 30 psig.

7-11. TURBOPUMP INLET DUCT TEST PLATE KIT 9016713. (See figure 7-8). Turbopump inlet duct test plate kit 9016713 consists of container VD192-0008-0015 (lower pad removed) and test plate 9019858. Test plate 9019858 consists of a metal plate with bolts, a seal, a fitting for monitoring pressure, and a 50-psig relief valve. The maximum operating pressure is 30 psig. The plate is adaptable to both oxidizer and fuel turbopump inlet ducts and is used during oxidizer and fuel system leak tests.

7-12. PRESSURE-ACTUATED PURGE VALVE TEST PLATE KIT 9025400 AND 9025400-11. (See figure 7-9.) Pressure-actuated purge valve test plate kit 9025400 consists of container VD192-0002-0844, test plate 9025399, 4 bolts MS9034-14, 4 washers LD153-0010-0009, and packing MS29513-012. Pressure-actuated purge valve test plate kit 9025400-11 consists of container VD192-0002-0844, test plate 9025399, 4 bolts RD111-1010-3417, 4 washers LD153-0013-0002, and packing MS29513-012. A streamer that cautions removal of test plate before firing is attached to the test plate. The test plate is used to block pneumatic control pressure at the OTBV opening control port, purge control valve inlet port, and STDV drain port. Instructions for the use of kit 9025400-11 are in R-3825-1B.

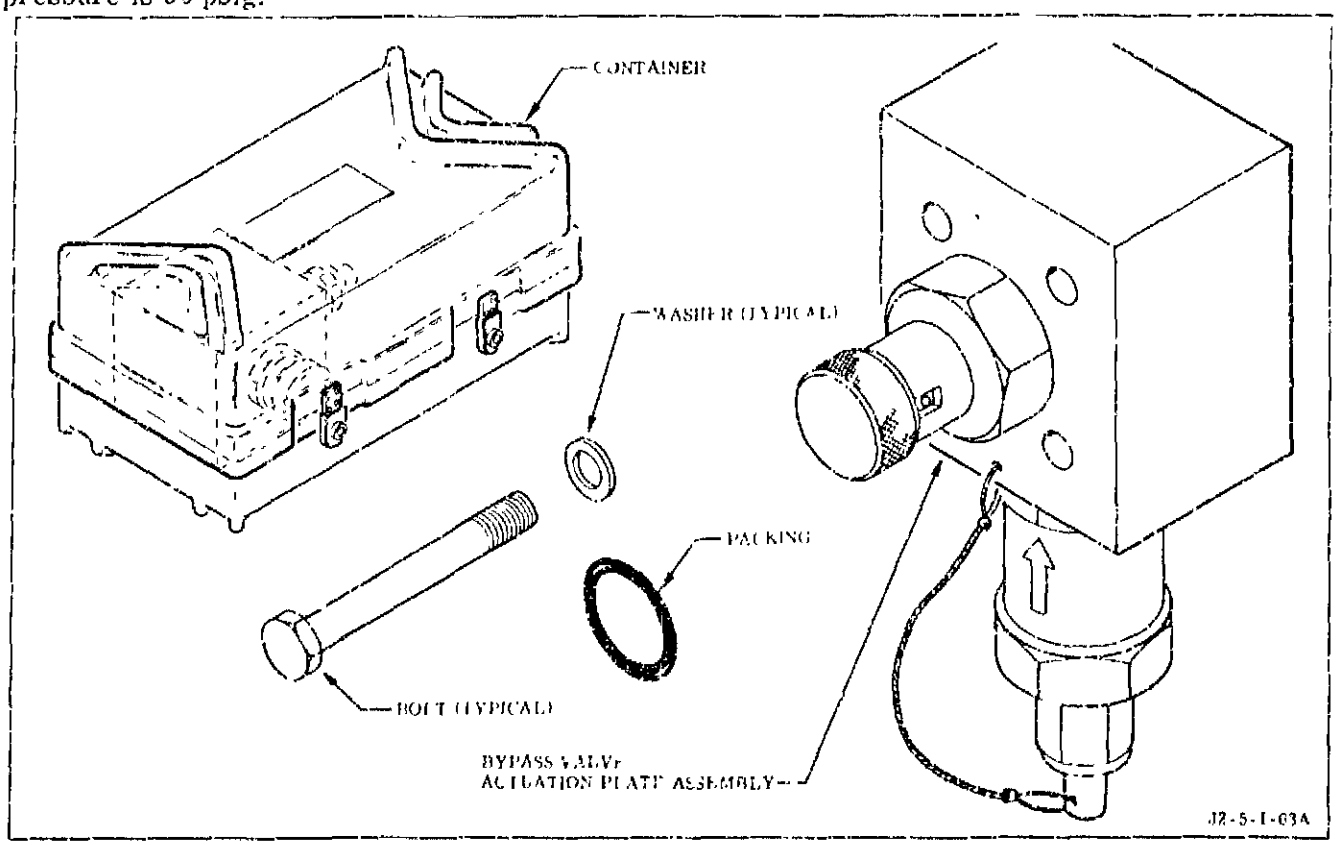

Figure 7-7. Bypass Valve Actuation Plate Kit 9016723-11

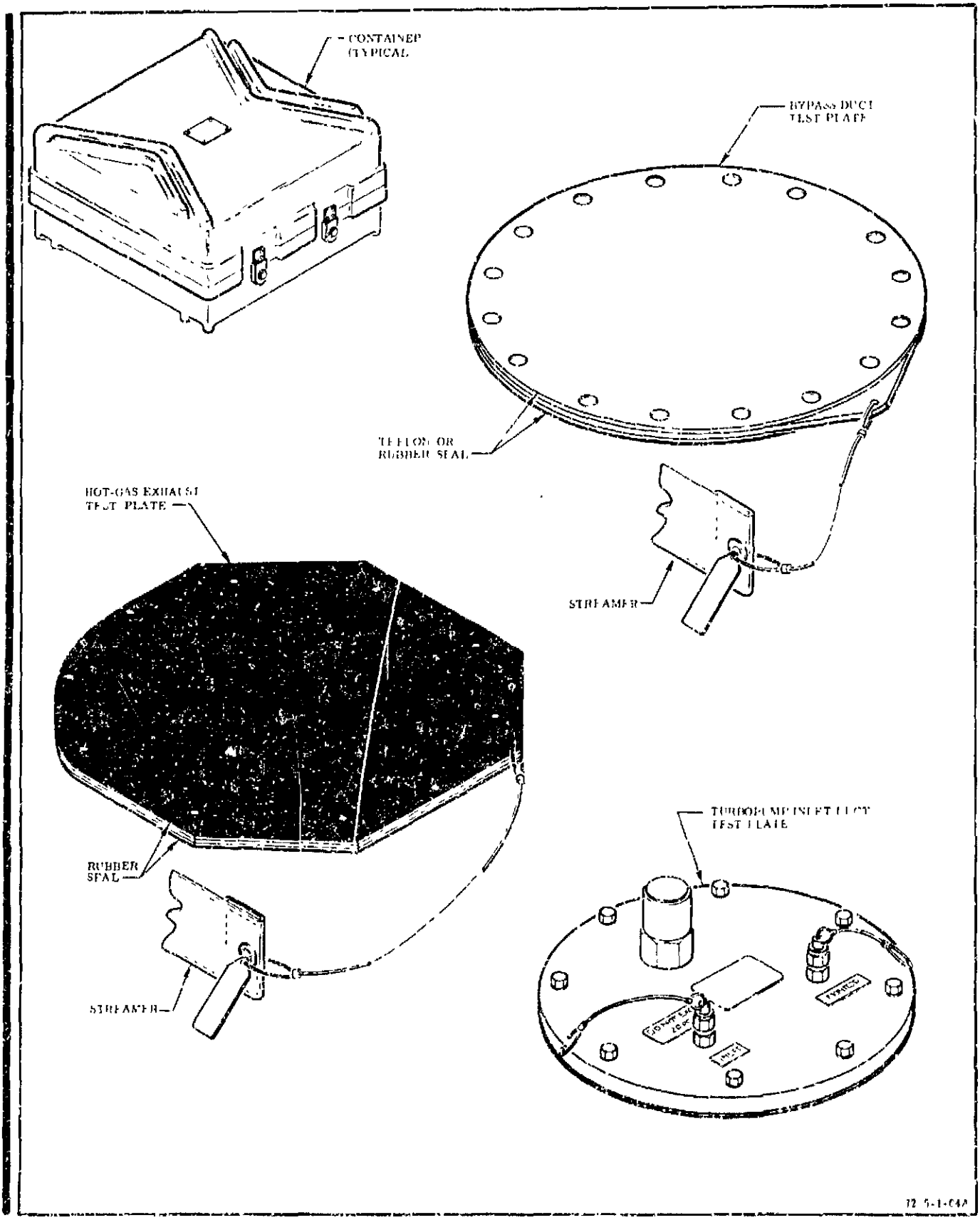

Figure 7-8. Test Plate Kits 9016701, 9016710, and 9016713

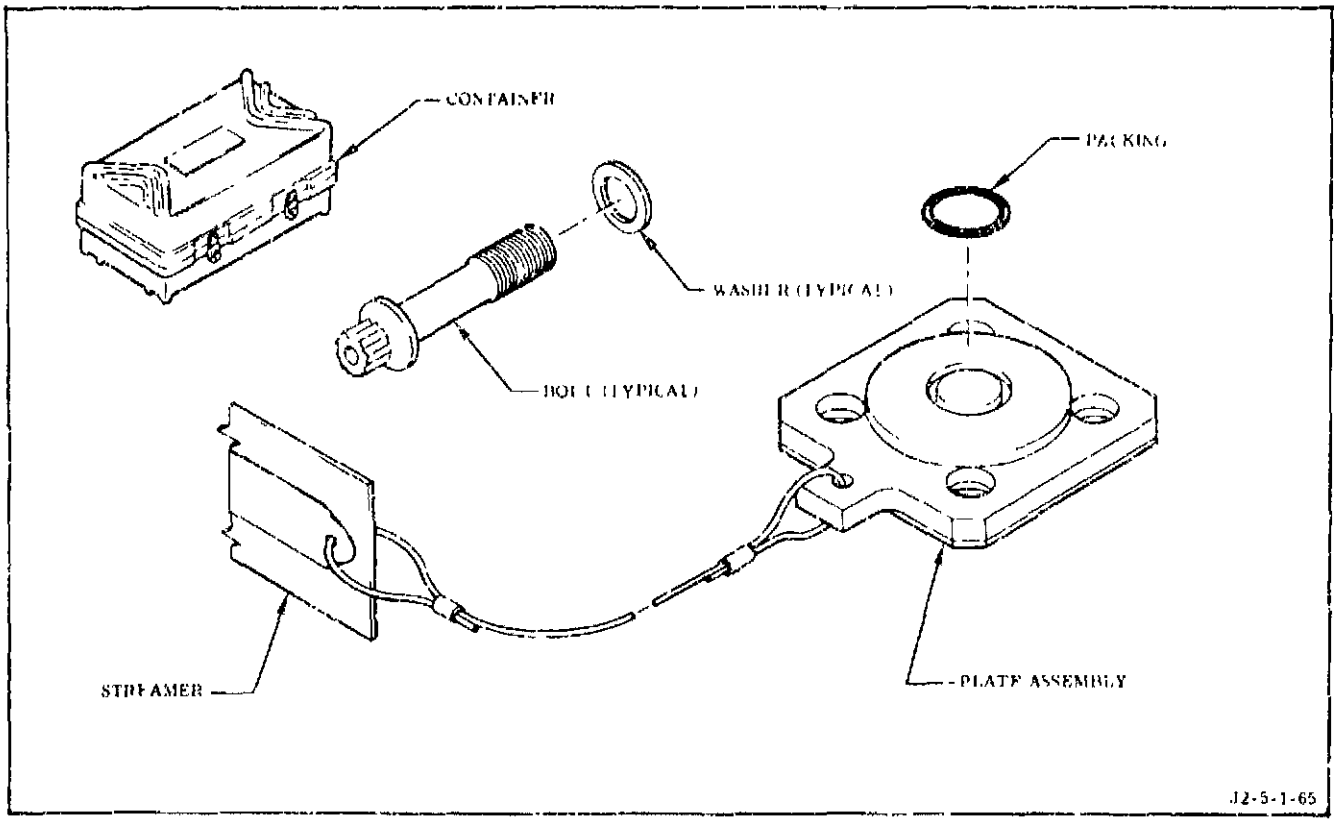

Figure 7-9. Pressure-Actuated Purge Valve Test Plate Kit 9025400

7-13. ACCUMULATOR HOSE PLATE KIT 9019960. (See figure 7-10.) Accumulator hose plate kit 9019960 consists of container VD192-0002-0844, test plate 9019961, 4 bolts AN4-14A, 8 washers LD153-0010-0009, and 4 nuts NAS679C4W. The kit seals the accumulator hose when the hose is disconnected during checkout. The test plate is metal with a flat rubber gasket on a raised face.

7-14. THRUST CHAMBER START TANK REFILL FLANGE TEST PLATE KIT 9024997. (See figure 7-11.) Thrust chamber start tank refill flange test plate kit 9024997 consists of container VD192-0002-0844, test plate 9025824, 4 bolts AN4-15A, 4 washers LD153-0010-0009, and 4 nuts MS9356-10. Test plate 9025824 is used to close off the start tank refill line for proper purging of the liquid refill check valve during the engine drying procedure.

7-15. OXIDIZER DOME PURGE ADAPTER KIT 9019975. (See figure 7-12.) Oxidizer dome purge adapter kit 9019975 consists of container VD192-0002-0884, adapter 210605, 4 plugs AN814-4CL, 4 seals 12100CR4 (Harrison Mfg Co), and seal 408767. The oxidizer dome purge adapter kit is used to support purging of the engine oxidizer dome prior to thrust chamber preconditioning and after engine cutoff during static engine operation. During purging operations, the adapter reduces recirculation of the purge gas that carries moisture-laden gases from the combustion zone of the thrust chamber back into the dome, forming ice on the cold surfaces of the injector. Adapter 210605 is a probe-shaped fitting with an inlet port, 4 instrumentation ports, and 76 outlets in the probe. The probe is provided with a threaded section for installation of the adapter into the injector instrumentation port. During the test operation, four plugs and/or facility pressure and temperature instruments supplied with seals are used in the 4 ports of the adapter, as required. Seal 408767 is provided for installation of the adapter into the engine injector port. The adapter, plugs, and seals are stored in the reusable container.

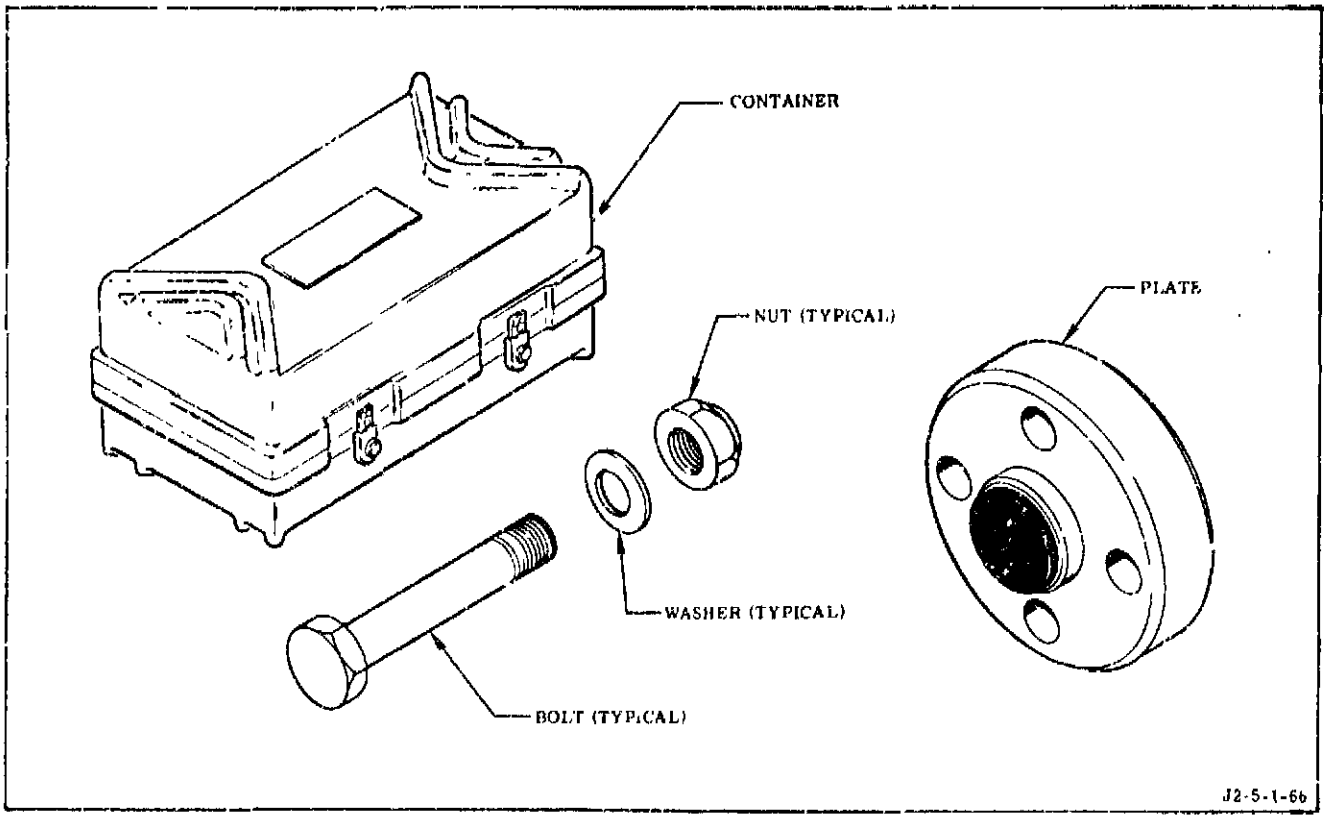

Figure 7-10. Accumulator Hose Plate Kit 9019960

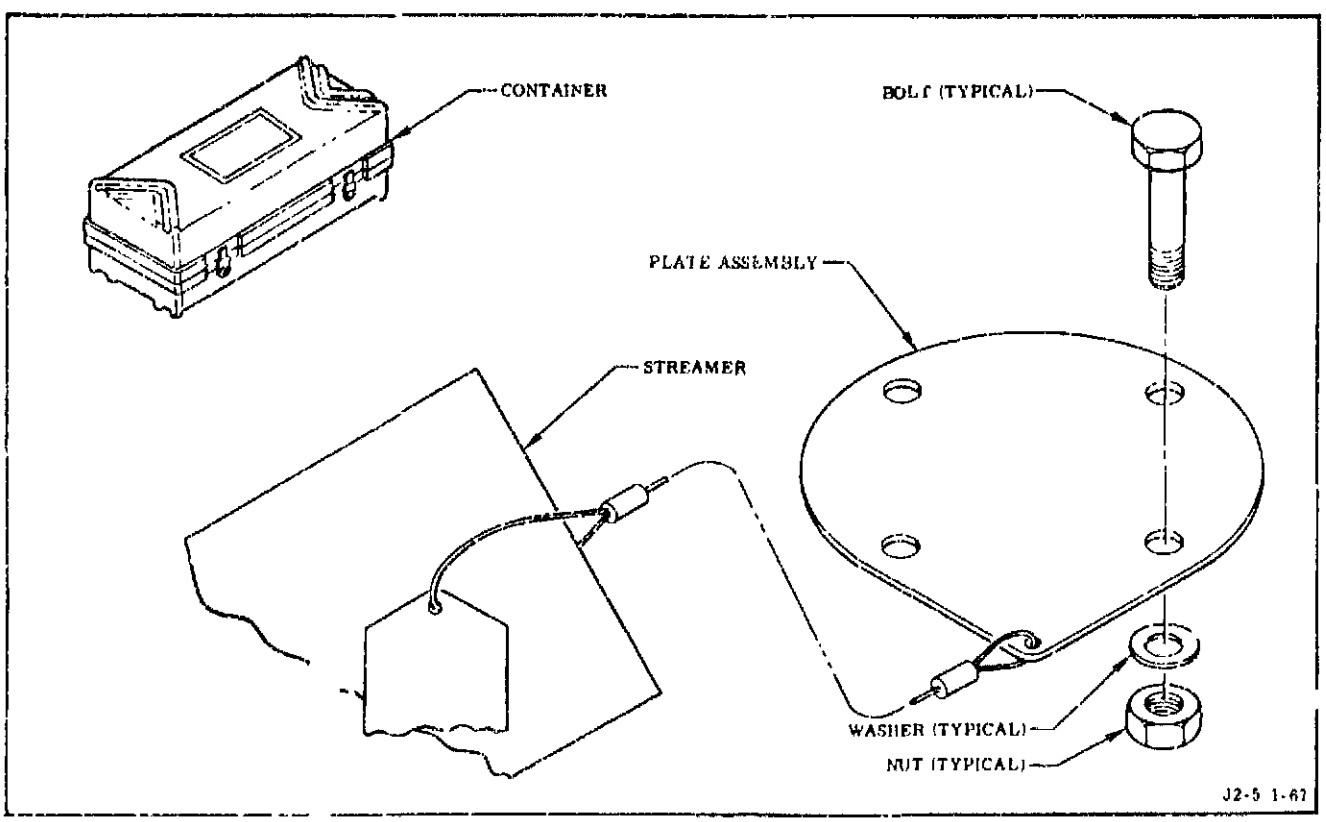

Figure 7-11. Thrust Chamber Start Tank Refill Flange Test Plate Kit 9024997

7-16. *OXIDIZER AND FUEL TURBINE DRAIN LINE TEST ADAPTER KIT 9024496.* (See figure 7-13.) The adapter kit consists of container VD192-0002-0844 and test adapter 9024523. The adapter consists of a hose assembly, a clamp, inlet fitting for pressurizing, and a burst diaphragm rated at 50 psig. The maximum operating pressure of the adapter is 30 psig. The adapters are connected to the oxidizer and fuel turbine seal bleed lines. This kit is used while performing oxidizer and fuel turbine seal cavity purge check valve reverse-flow tests.

7-17. *GAS GENERATOR EQUALIZATION LINE LEAK-TEST ADAPTER KIT 9024993.* (See figure 7-14.) The gas generator equalization line leak-test adapter kit consists of container VD192-6018-1644, adapter assembly 9025821, nut AN6289-4J, packing MS28778-4, and ring MS28777-4. The adapter assembly is equipped with an inlet fitting for pressurizing and a burst diaphragm rated at 50 psig. The maximum operating pressure of the adapter is 30 psig. The adapter assembly provides the capability to leak-test the gas generator equalization line.

7-18. *CALIBRATION PRESSURE SWITCH TEST ADAPTER KIT 9025405.* (See figure 7-15.) Calibration pressure switch test adapter kit 9025405 consists of container VD192-0002-0844 and test adapter 9025406. The test adapter has an inlet and outlet port and a burst diaphragm rated at 800 psig. The maximum operating pressure of the test adapter is 600 psig. The kit facilitates the calibration of the mainstage OK pressure switch.

7-19. *FUEL PUMP LEAK AND FLOW ADAPTER KIT 9025419.* (See figure 7-16.) Fuel pump leak and flow adapter kit 9025419 consists of container VD192-0002-1644, adapter assembly 9025420, and packing MS28778-6. The adapter assembly is equipped with an inlet fitting for pressurizing, a burst diaphragm rated at 90 psig, an adapter, and an interconnecting flexible hose. The adapter assembly provides overpressurization protection for the fuel pump seals during leak test of the fuel seal cavity purge check valve and the fuel pump intermediate seal, and during leak and flow test of the fuel seal cavity bleed check valve.

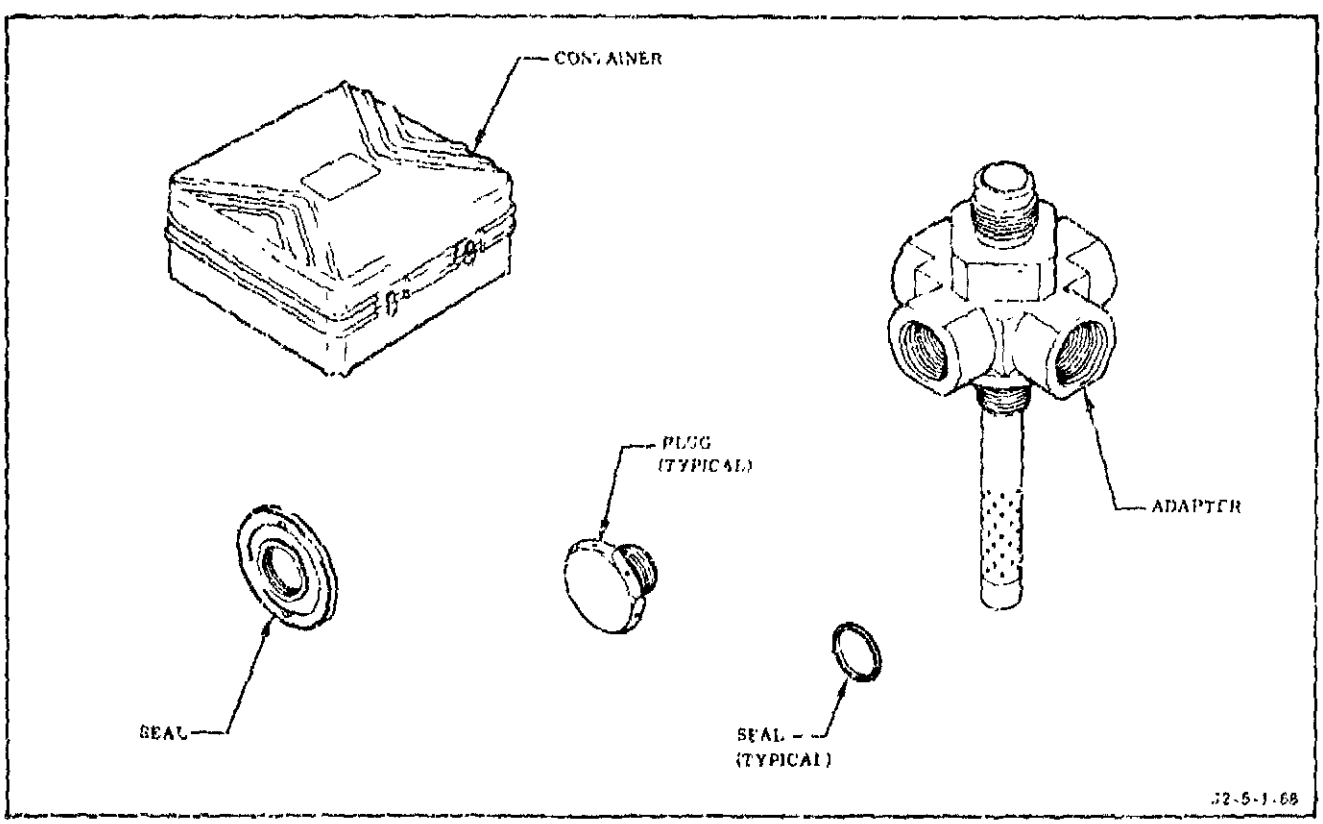

Figure 7-12. Oxidizer Dome Purge Adapter Kit 9019975

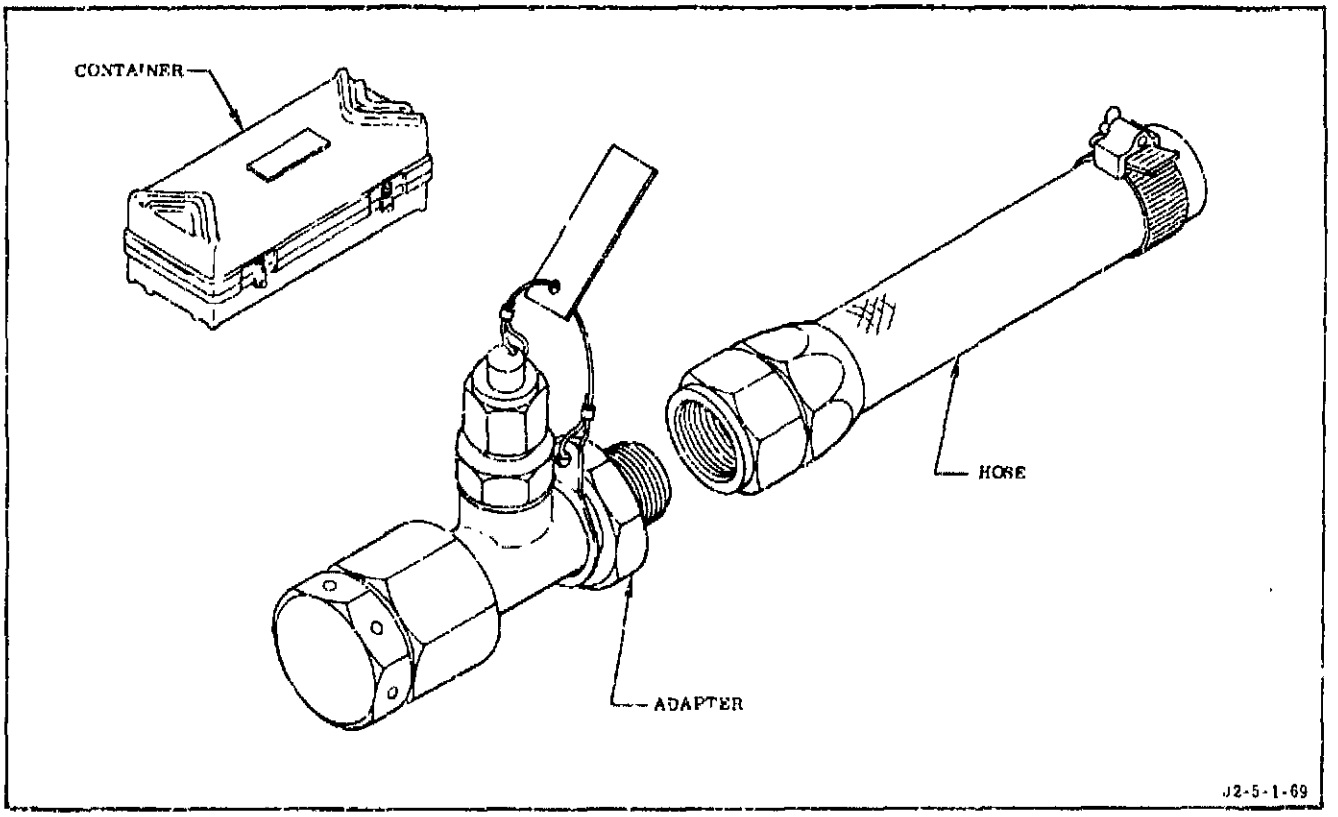

Figure 7-13. Oxidizer and Fuel Turbine Drain Line Test Adapter Kit 9024496

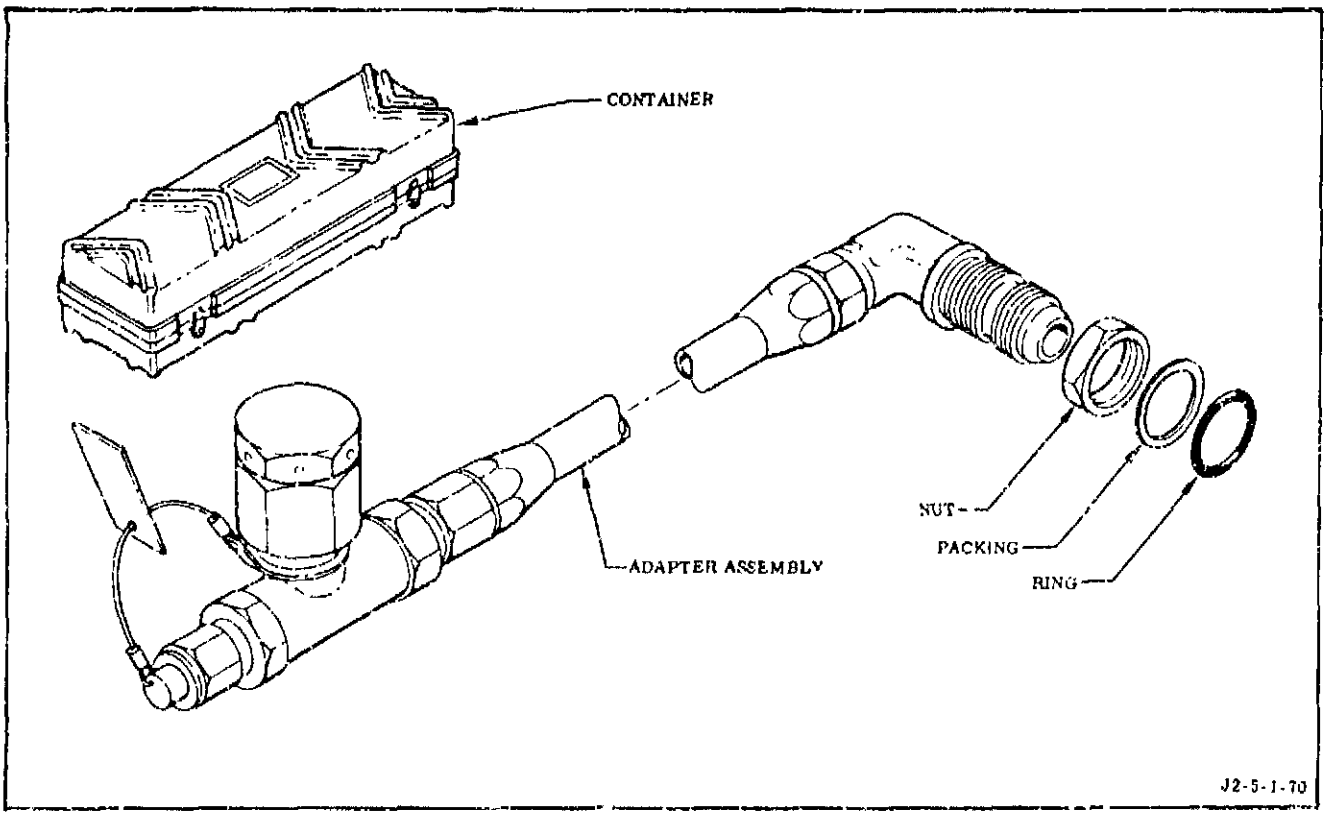

Figure 7-14. Gas Generator Equalization Line Leak-Test Adapter Kit 9024998

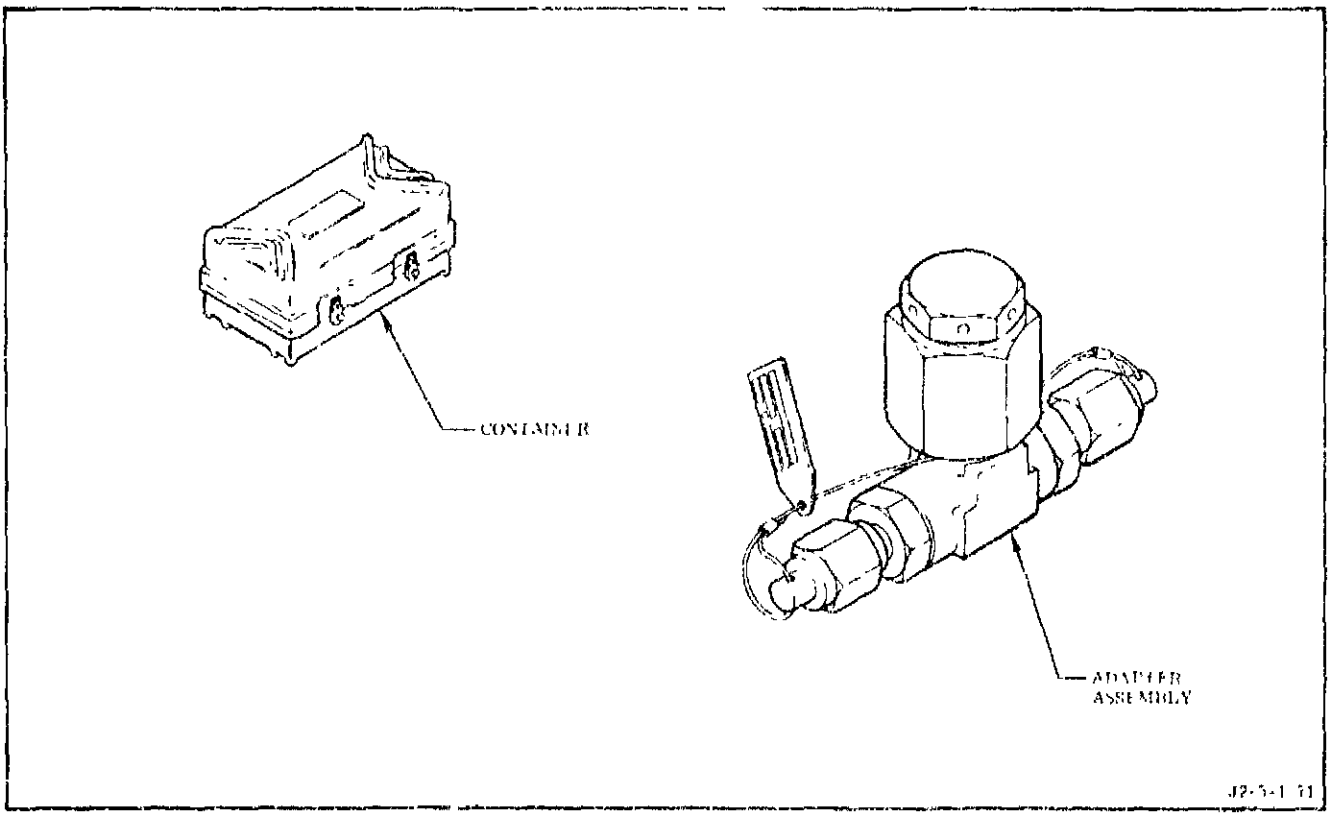

Figure 7-15. Calibration Pressure Switch Test Adapter Kit 9025405

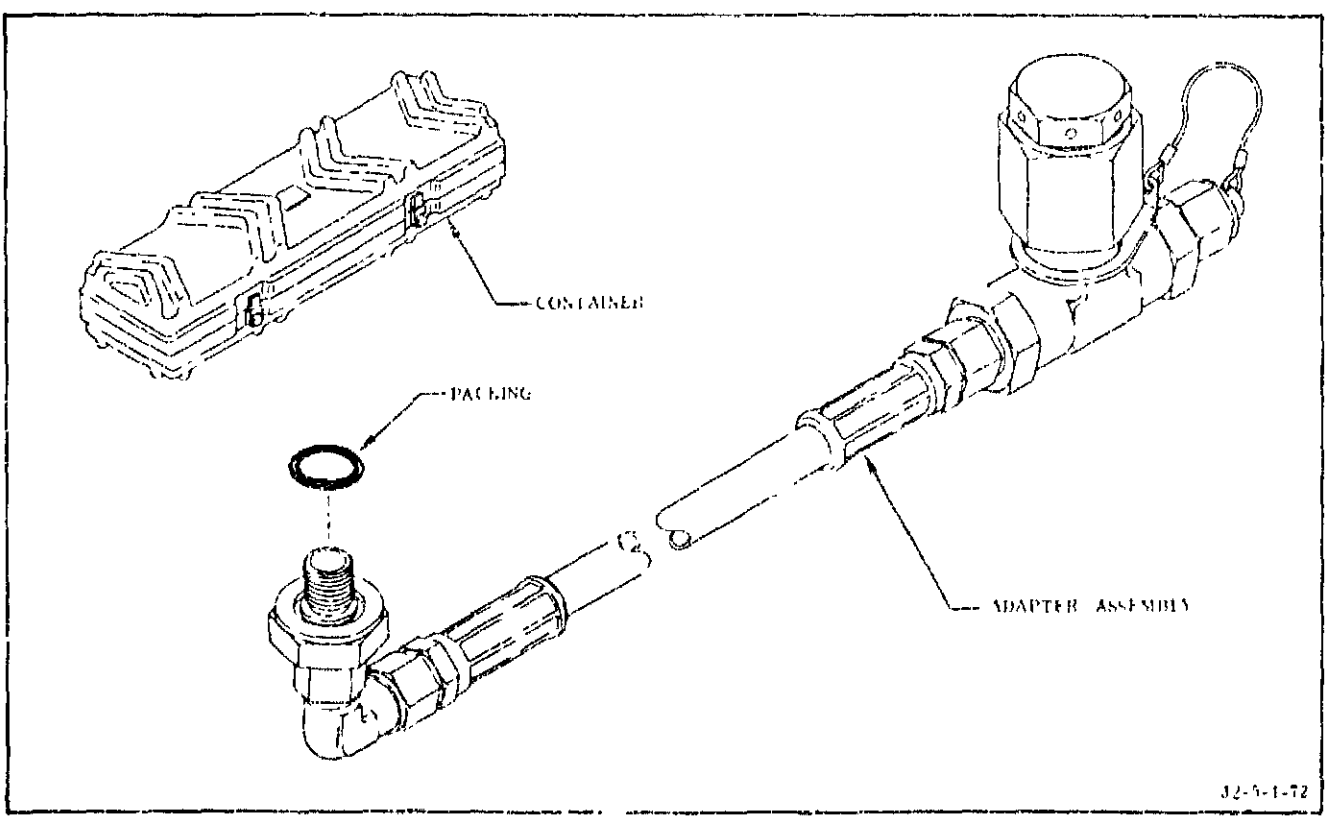

Figure 7-16. Fuel Pump Leak and Flow Adapter Kit 9025419

7-20. VENT ADAPTER KIT 9025424. (See figure 7-17.) The vent adapter kit consists of container VD192-0002-0844, adapter assembly 9025423, and packing MS28778-4. The vent adapter assembly provides a bleed valve which permits selection of the vent open or closed position to conserve the helium pressurant utilized during leak tests and checkout operations. During tests, the vent adapter assembly is used in place of the vent port relief valve 553364 located in the line from the ignition-phase solenoid normally open port to the MFV closing port.

7-21. OXIDIZER TURBOPUMP SEAL CAVITY DRAIN LINE TEST ADAPTER KIT 9025817. (See figure 7-18.) Oxidizer turbopump seal cavity drain line adapter kit 9025817 consists of a container VD192-0002-1286 and an adapter assembly 9025818. Adapter assembly 9025818 incorporates an inlet fitting for pressurizing, a hose and clamps for attaching to the oxidizer turbopump seal cavity drain line, and a burst diaphragm for protecting the system from overpressurization. The burst diaphragm has a burst pressure of 50 psig. The adapter provides the capability to check out the oxidizer turbopump intermediate seals.

7-22. OXIDIZER DOME PURGE SHUTOFF PLUG KIT 9020784-11. (See figure 7-19.) Oxidizer dome purge shutoff plug kit 9020784-11 consists of container VD192-0002-0844 and a plug incorporating a manual vent valve. The plug is used during engine leak and sequence tests to prevent escape of the pneumatic control system pressure through the oxidizer dome purge check valve. The manual vent valve in the plug is used to vent the pneumatic control system at the termination of tests.

7-23. METERING VALVE KIT 9024718. (See figure 7-20.) Metering valve kit 9024718 consists of container VD192-0002-0884 and manually operated metering valve assembly 9024719. The metering valve port fittings provide for adapting existing hose assemblies of Pneumatic Checkout Console G3106 and Pneumatic Flow Tester G3104.

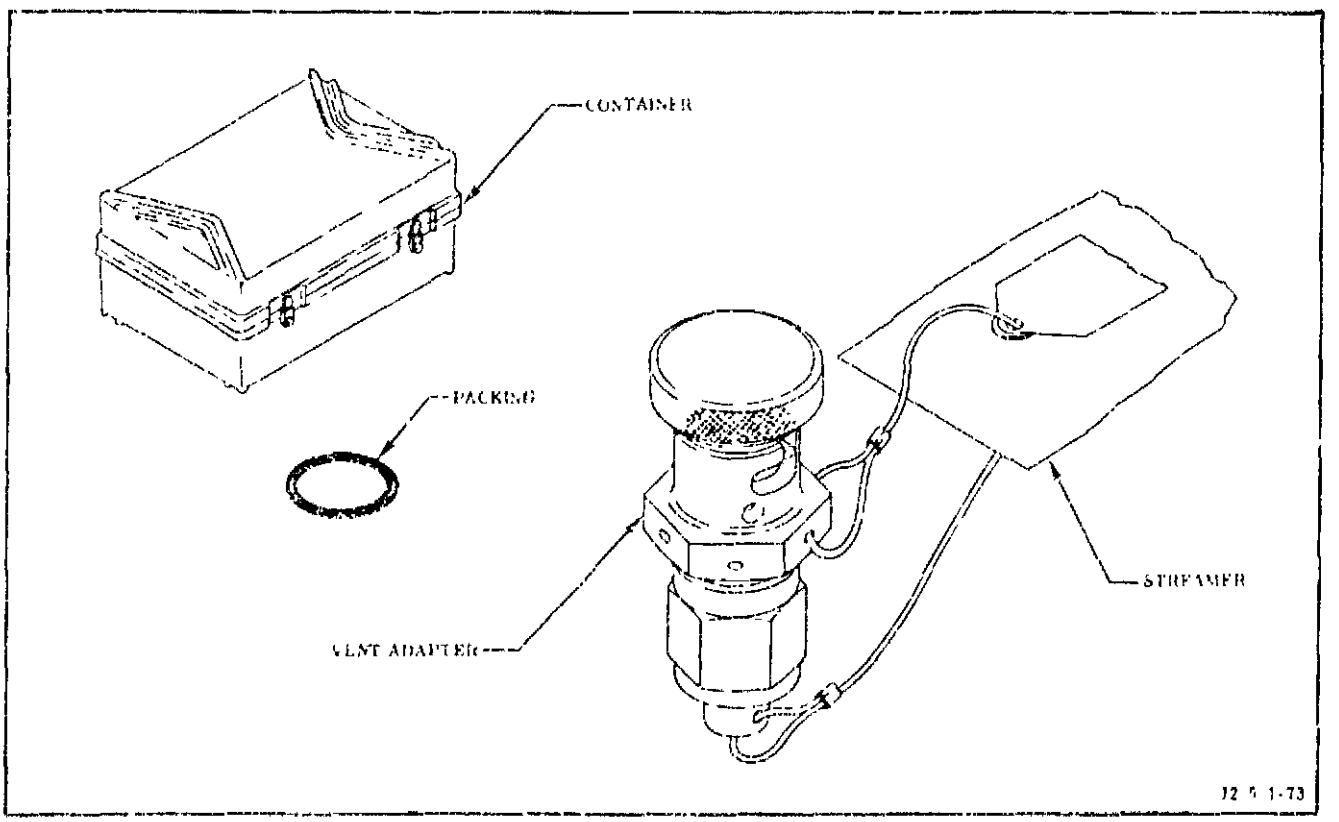

Figure 7-17. Vent Adapter Kit 9025424

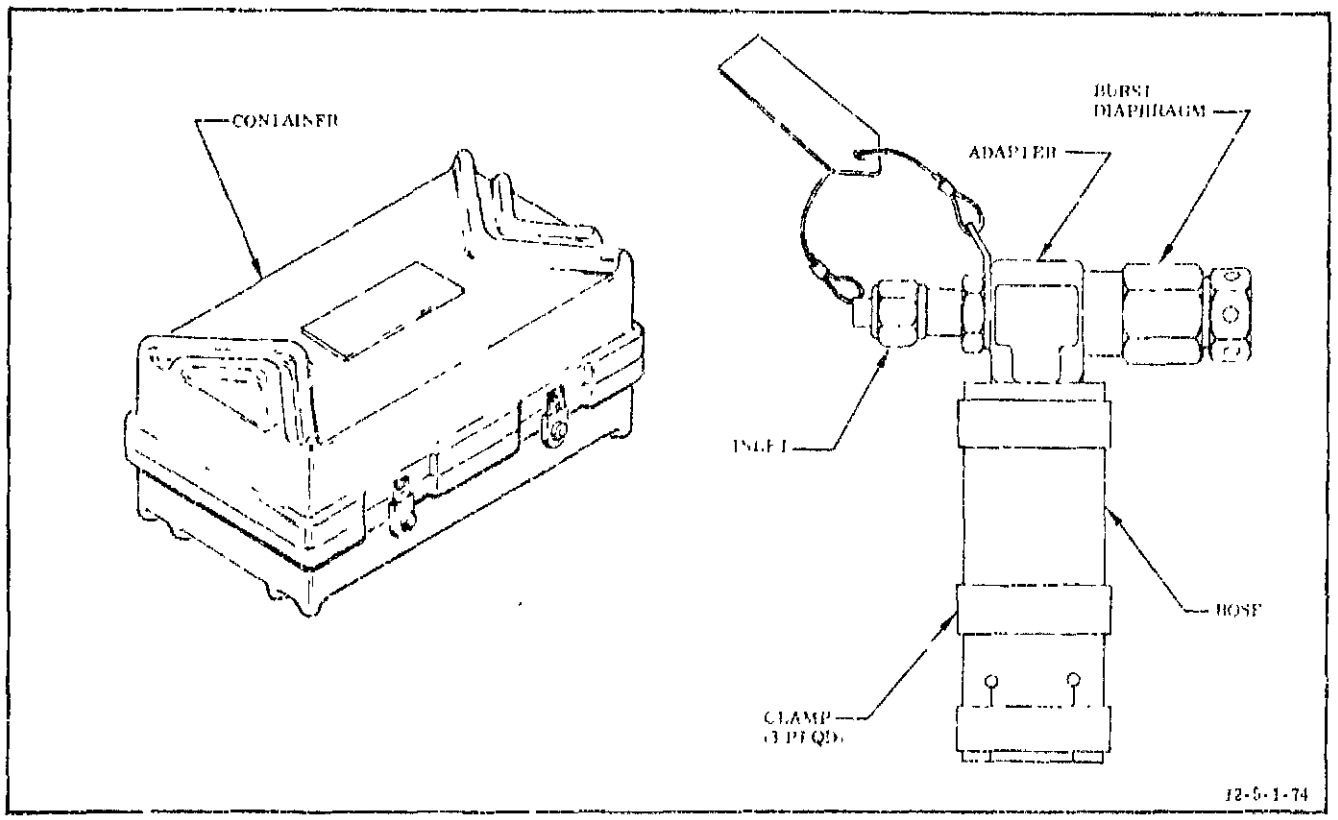

Figure 7-18. Oxidizer Turbopump Seal Cavity Drain Line Test Adapter Kit 9025817

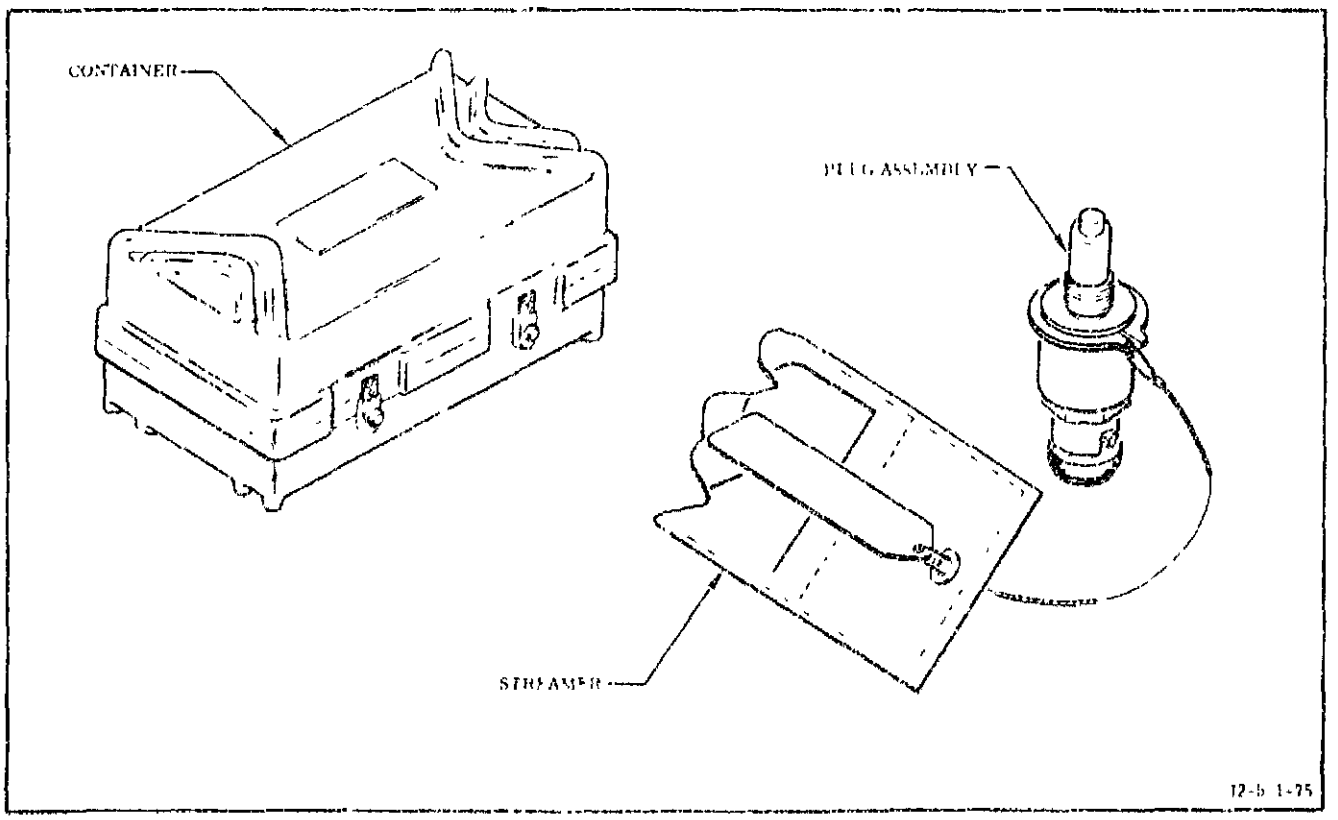

Figure 7-19. Oxidizer Dome Purge Shutoff Plug Kit 9020784-11

7-24. BYPASS VALVE REMOVAL TOOLKIT 9020269. (See figure 7-21.) The bypass valve removal toolkit consists of container VD192-0002-0844, lower bracket 9021015, upper bracket 9021016, 4 bolts AN103811, and 4 washers LD153-0011-0014. The rod of the lower bracket fits into the bore of the upper bracket. A screwjack on the rod of the lower bracket is used to vary the distance between the 2 brackets. The tool is used to compress the thrust chamber manifold bellows and fuel turbine exhaust duct bellows for installing or removing the oxidizer turbine bypass valve, seals, or the test plate used for leak-testing the gas generator and exhaust system.

7-25. TURBOPUMP TORQUE WRENCH KITS 9016711-21, 9016712-11, AND 9017259. (See figure 7-22.) The fuel and oxidizer turbine torque wrench kits are used to rotate the turbines during leak tests. Fuel turbine torque wrench kit 9016711-21 and oxidizer turbine accessory drive torque wrench kit 9016712-11 contain shaft-shaped wrenches (9019861 in kit 9016711-21, and 9019875-11 in kit 9016712-11) approximately 14 inches long, incorporating a spline on one end to adapt to the respective pump shafts and with the other end hex-shaped for torque wrench adaptation. Fuel turbine torque wrench kit 9016711-21 also contains an adapter 19-9025816 to provide the capability for determining the breakaway and running torque of the stud-driven turbopump during the fuel feed system leak test. The adapter is approximately 13 inches long, incorporating a 1/2-inch-square female drive on one end and a 7/16-inch-hex female drive on the other end, all made of nonsparking material. The oxidizer turbine accessory drive torque wrench is used when the hydraulic pump is not installed on the accessory drive pad. When the hydraulic pump is installed oxidizer turbine accessory drive shaft torque wrench kit 9017259 is used. This kit contains wrench adapter C-90098-BC (Proto Tool Co) also of nonsparking material, utilizing an open-ratchet-type head on one end, to rotate the pump quill shaft, and a 1/2-inch-square hole on the other end for torque wrench adaptation.

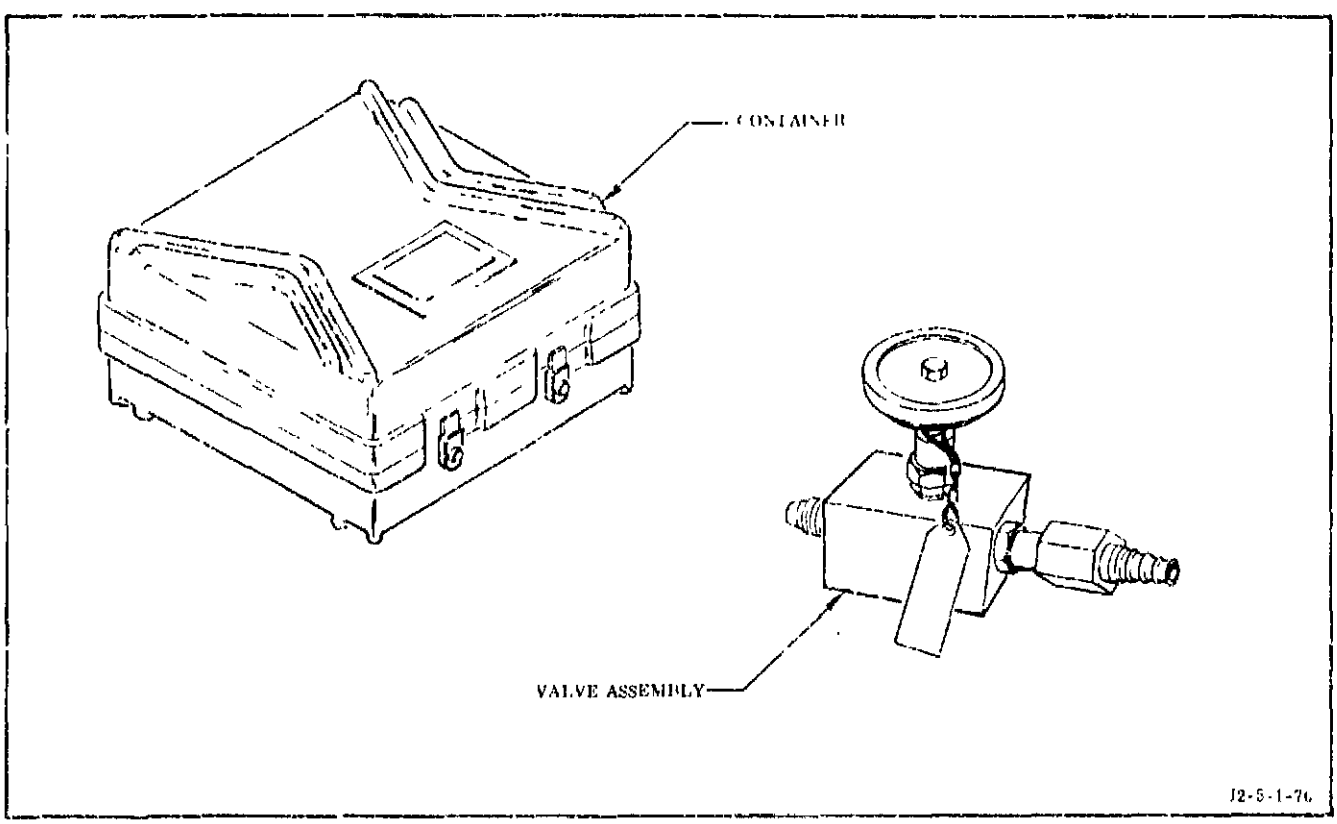

Figure 7-20. Metering Valve Kit 9024718

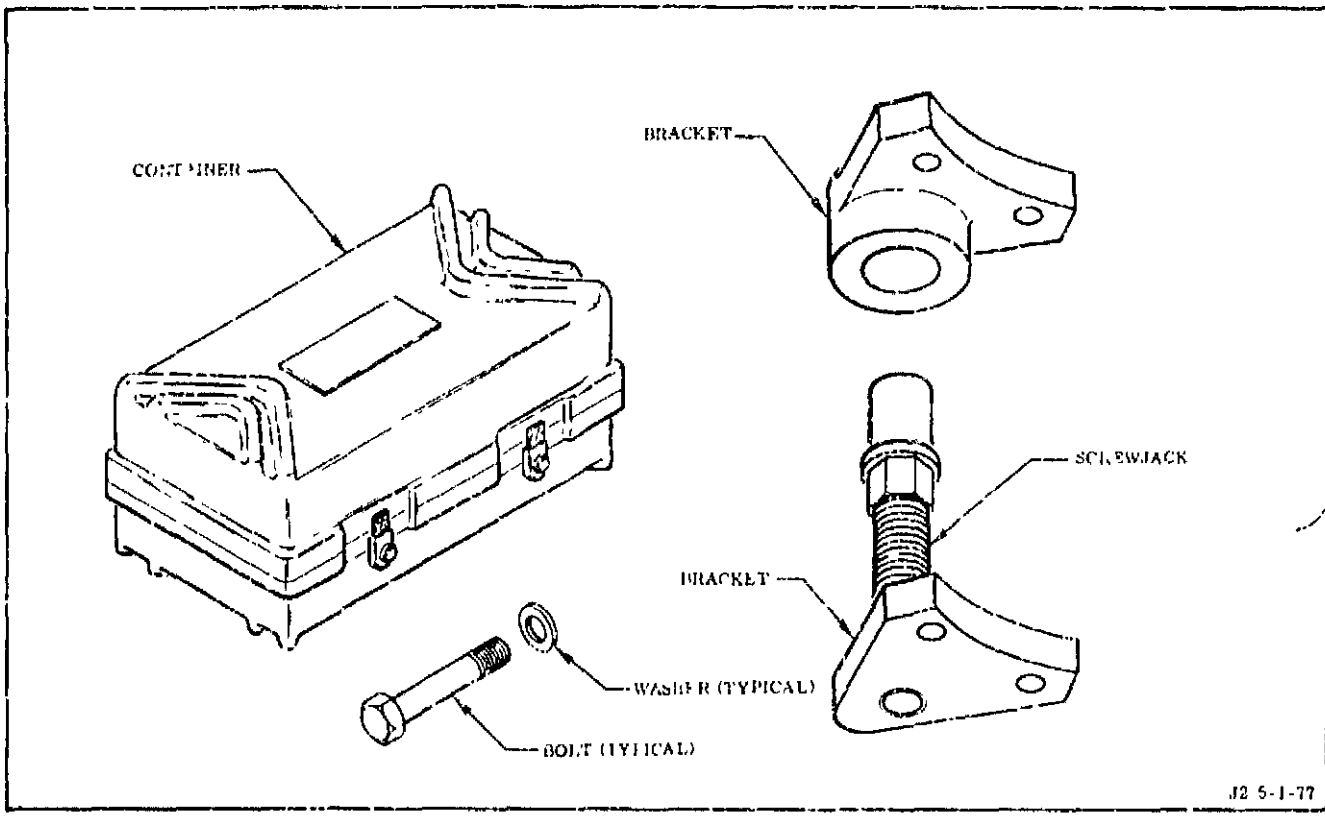

Figure 7-21. Bypass Valve Removal Toolkit 9020269

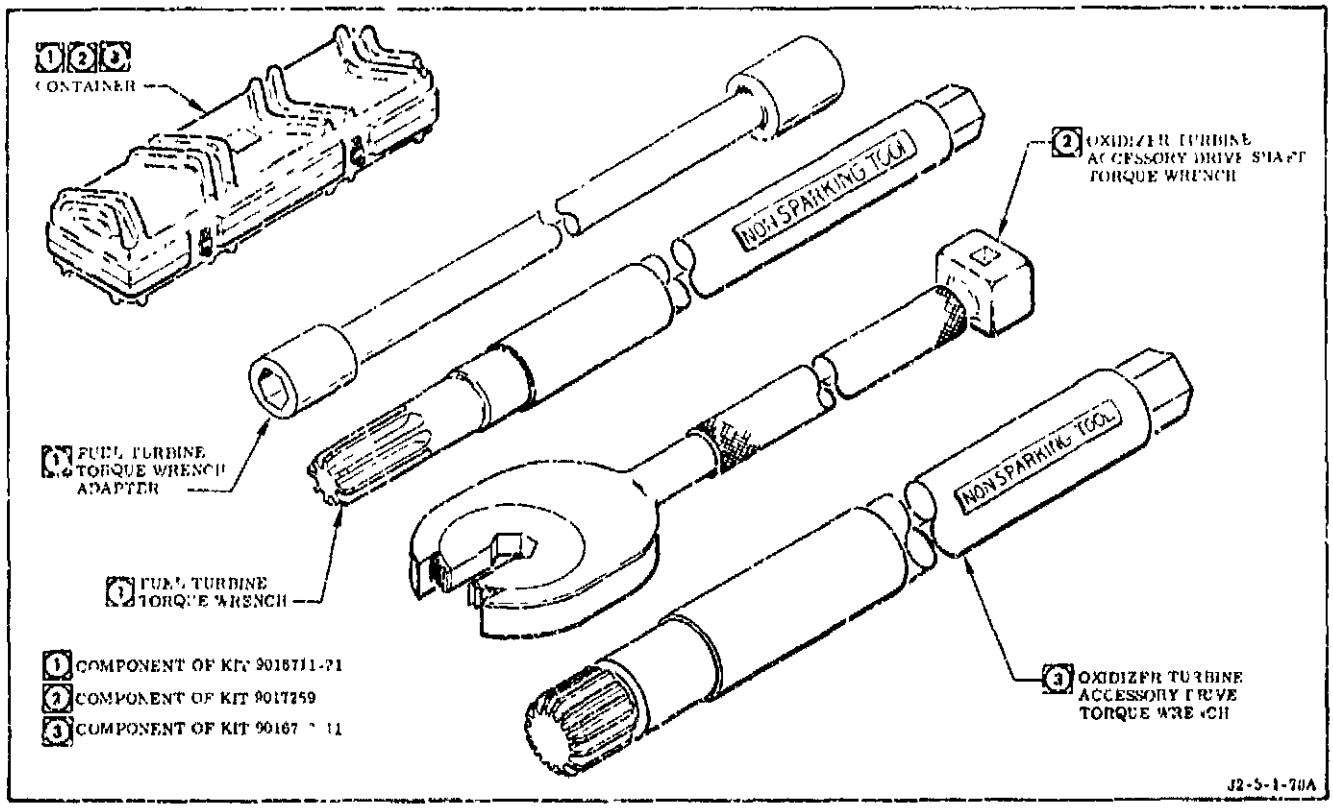
1 2 3
CONTAINER
NON-SPARKING TOOL
2 OXIDIZER TURBINE ACCESSORY DRIVE SHAFT TORQUE WRENCH
1 FUEL TURBINE TORQUE WRENCH ADAPTER
1 FUEL TURBINE TORQUE WRENCH
NON-SPARKING TOOL
1 COMPONENT OF KIT 9016711-21
2 COMPONENT OF KIT 9017259
3 COMPONENT OF KIT 9016712-11
3 OXIDIZER TURBINE ACCESSORY DRIVE TORQUE WRENCH
J2-5-1-78A

Figure 7-22. Turbopump Torque Wrench Kits 9016711-21, 9016712-11, and 9017259

7-26. INSULATOR INSTALLER TOOLKIT 9024994. (See figure 7-23.) Insulator installer toolkit 9024994 consists of container VD192-0002-0844, installer 9024995, and hook 200, size 11 (Boye Needle Co). The hook is used to remove electrical connector pin insulators, and the installer is used to install electrical connector pin insulators.

7-27. FLIGHT INSTRUMENTATION PRESSURE TRANSDUCER REMOVAL TOOLKIT 9024999. (See figure 7-24.) Flight instrumentation pressure transducer removal toolkit 9024999 consists of container VD192-0002-0844, 2 pressure transducer removal torque wrenches 9025822, 2 bolts AN4-4A, 2 washers LD153-0010-0010, transducer boss plug 9025823, 2 bolts RD111-1010-3408, and 2 washers LD153-0013-0002. One torque wrench is used to hold the transducer body and the other torque wrench is used to hold the electrical wiring plug assembly while removing or reinstalling the plug assembly.

7-27A. HEAT EXCHANGER OXIDIZER SUPPLY LINE TEST PLATE KIT 9019968. (See figure 7-24A.) The heat exchanger oxidizer supply line test plate kit 9019968 consists of test plate 9025871, 8 bolts AN4-16A, 8 washers LD153-0010-0010, 8 nuts MS9356-10, and container VD192-0007-0018. The kit is used for engine vacuum drying and gaseous back filling of the heat exchanger oxidizer supply system and the start tank gaseous refill line and system. The test plate contains two ports, each of which is provided with a 1/4-inch fitting. Each fitting has a pressure cap for sealing the port when not in use. Protection from overpressurization is provided by a 120-psig burst diaphragm.

7-27B. GAS GENERATOR CONTROL VALVE TEST PLATE KIT 9019969. (See figure 7-24B.) The gas generator control valve test plate kit 9019969 consists of test plate 9025853, 4 bolts AN4-14A, 4 bolts RD111-1009-3416, 4 washers LD153-0013-0002, 4 nuts MS9356-10, and container VD192-0002-2444. The kit is used to actuate the gas generator control valve for purging of the gas generator fuel and oxidizer lines and also for purging, vacuum drying, and gaseous back filling of the start tank liquid refill line and system. Protection from overpressurization is provided by a 400-psig burst diaphragm.

7-27C. START TANK SYSTEM DRYING MANIFOLD KIT 9025826. (See figure 7-24C.) The start tank system drying manifold kit 9025826 consists of manifold 9025852 and container VD192-0007-0018. The manifold is a 12-inch-long hexagon bar provided with one 1/2-inch and eleven 1/4-inch fittings to which hoses are attached when drying the engine start tank system. Each fitting is provided with a pressure cap for sealing the fitting when not in use.

7-27D. RESISTANCE TEST ADAPTER KIT 9025591. (See figure 7-24D.) The resistance test adapter kit 9025591 consists of electrical harness assembly 9025590 and container VD192-0002-0844. The kit is used when performing a resistance-to-ground test of the engine electrical system. The harness is a single 36-inch test lead connected to an electrical connector MS3100R32-7S, which has all of its contacts electrically interconnected.

7-28. MAINTENANCE AND REPAIR OF TEST PLATES, ADAPTERS, AND TOOLS.

7-29. Maintenance tasks required for test plates, adapters, plugs, meter valves, tools, and torque wrench kits are listed in figure 7-25. The information presented lists the tasks to be performed, indicates when the tasks are to be performed, and lists the paragraphs to be referenced.

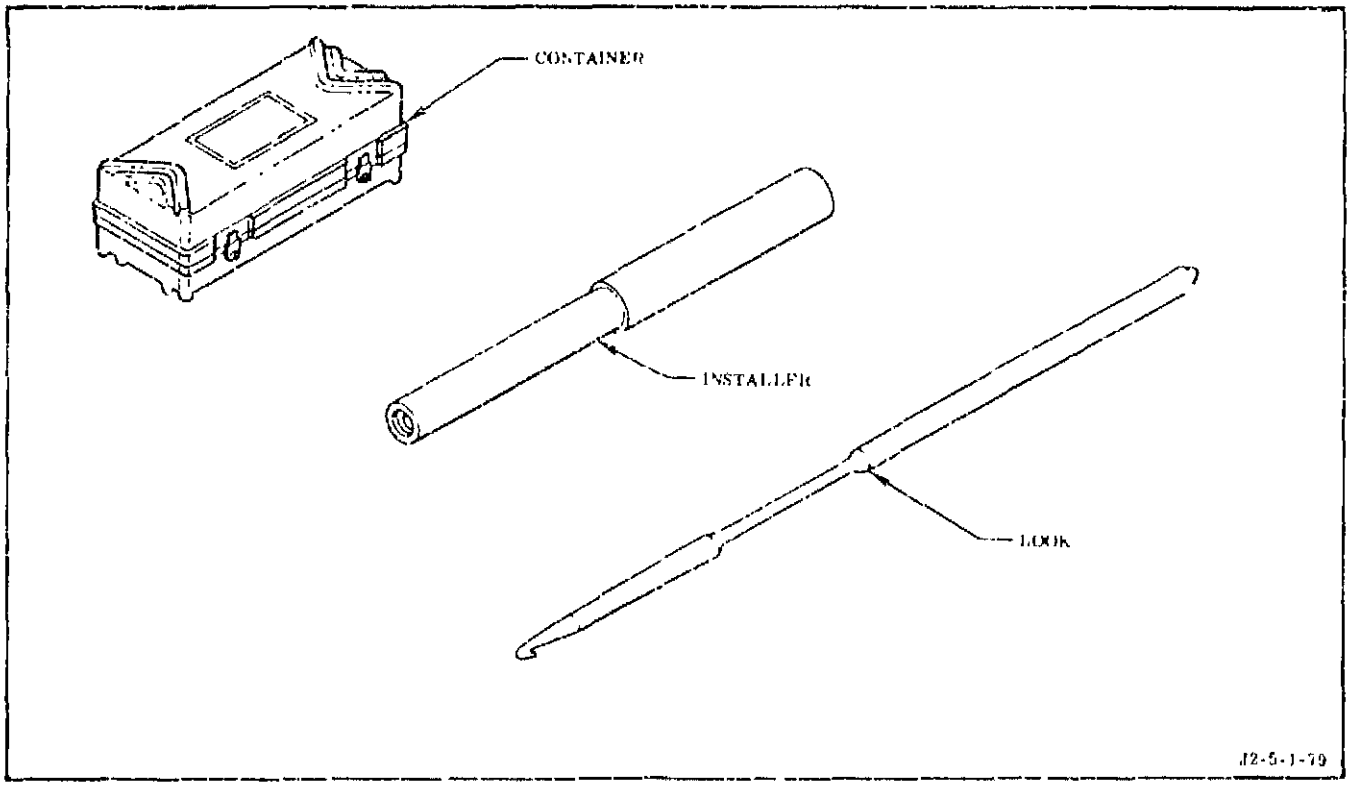

Figure 7-23. Insulator Installer Toolkit 9024994

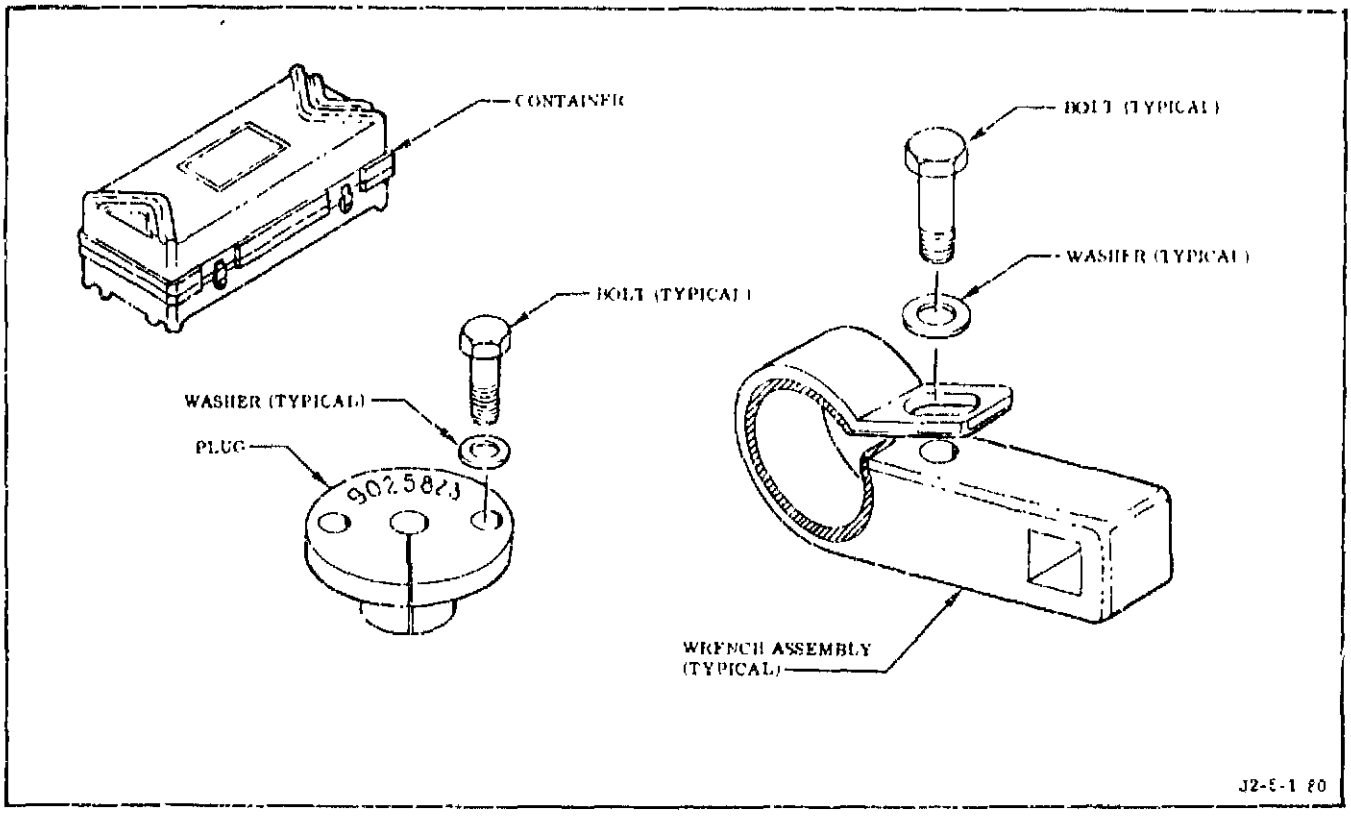

Figure 7-24. Flight Instrumentation Pressure Transducer Removal Toolkit 9024999

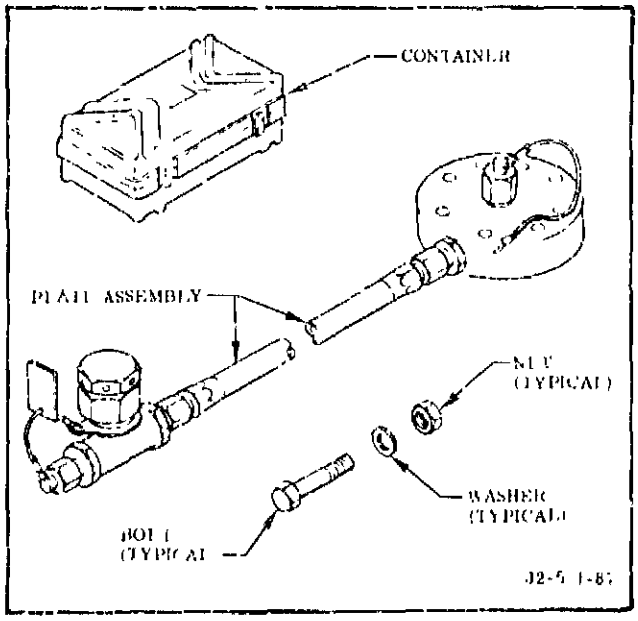

Figure 7-24A. Heat Exchanger Oxidizer Supply Line Test Plate Kit 9019968

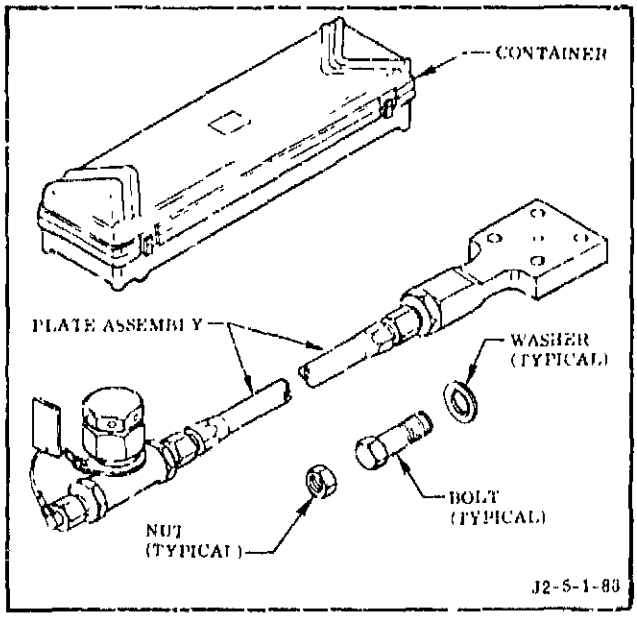

Figure 7-24B. Gas Generator Control Valve Test Plate Kit 9019969

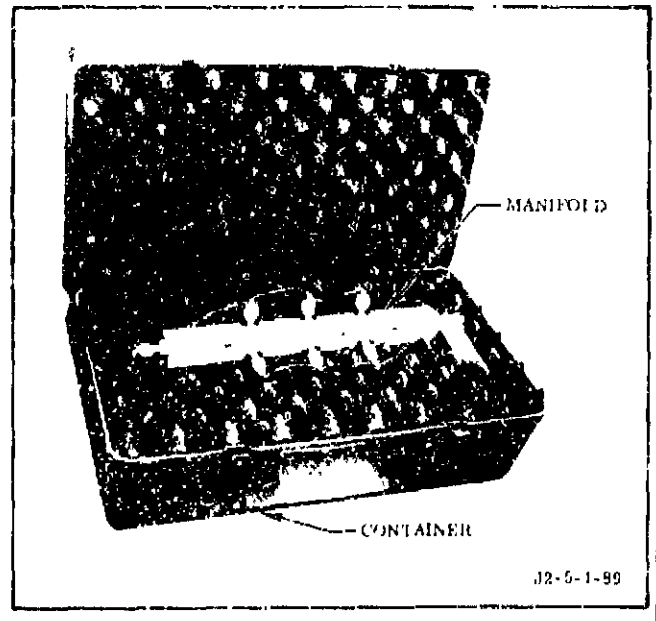

Figure 7-24C. Start Tank System Drying Manifold Kit 9025826

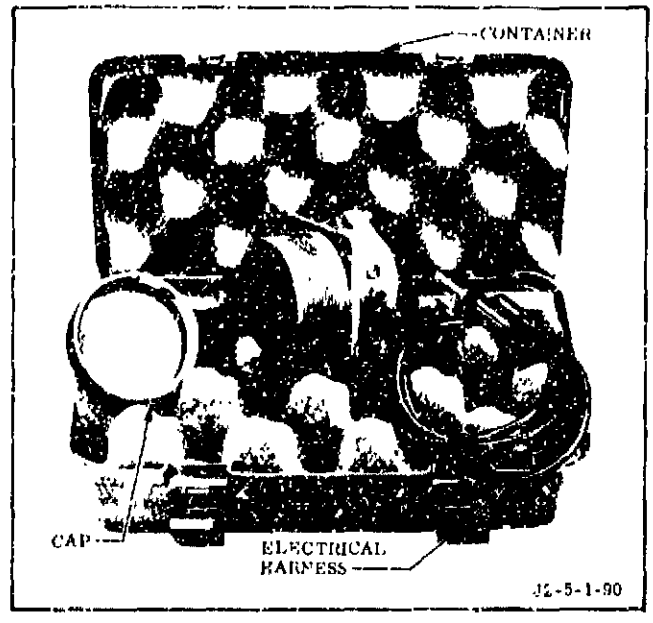

Figure 7-24D. Resistance Test Adapter Kit 9025591

Requirements	Receiving	Prior to Use	Storage	Special	Remarks
Inspect each kit for completeness.	X	X	X		Refer to paragraph 7-1.
Inspect test plates for evidence of nicks or scratches on sealing surfaces.	X	X			Replace test plate, protective plastic film, Teflon sheet, or rubber gasket, as applicable. Refer to paragraphs 7-34, 7-35, and 7-36.
Inspect adapters, plugs, and fittings for damage to sealing surfaces.	X	X			Replace defective part.
Inspect test plates, plugs, tools, and adapters for cleanness.		X			Refer to paragraph 7-30.
Inspect O-rings, packings, seals, and gaskets for damage or wear.	X	X			Replace, as applicable.
Inspect plates, tubes, hoses, and burst diaphragm deflectors for plugged or obstructed passages.		X			Clean or replace, as applicable. Refer to paragraph 7-30. To replace burst diaphragms, refer to paragraph 7-31.
Inspect oxidizer dome purge adapter kit 9019975 for plugged outlet holes and for restricted internal passages in ports.	X	X			Replace adapter.
Inspect threaded surfaces for damage (including cross-threading, galling, and binding).		X			Replace damaged parts.
Inspect threads of plastic parts 9025421 (kit 9025419) and 9025402 (kit 9020784-11) for damage.		X			Replace damaged parts.
Inspect pressure transducer removal torque wrenches in flight instrumentation pressure transducer removal toolkit 9024999 for damaged cork pad.		X			Replace cork pad. Refer to paragraph 7-36A.
Inspect oxidizer dome purge adapter kit 9019975 for excess lubricant on threads.		X			
Inspect cables for security of attachment and for frayed or broken strands.		X			Replace cable.
Clean test plates, plugs, and adapters.			X	X	Refer to paragraph 7-30.
Clean tools and torque wrenches.			X	X	Refer to paragraph 7-30.
Clean burst diaphragms.				X	Refer to section I for cleaning and paragraph 7-31 for removal and installation information.
Clean streamers.				X	Whenever appearance indicates need. Refer to section I.
Lubricate O-rings, packings, and gaskets.				X	During reassembly (paragraph 7-33) of plate and adapter assemblies. Refer to paragraph 7-32.

Figure 7-25. Maintenance Requirements for Test Plates, Adapters, and Tools (Sheet 1 of 2)

Requirements	Receiving	Prior To Use	Storage	Special	Remarks
Lubricate fitting screw threads.				X	During reassembly (paragraph 7-33) of plate and adapter assemblies. Refer to paragraph 7-32.
Lubricate threads of bracket 9021015 and socket of bracket 9021016 (kit 9020269).		X			Use lubricant grease RB0140-012 (Rocketdyne).
Function-test relief valve RD284-5006-0500 of test plate kit 9016713.				X	Every 6 months or when a malfunction is suspected. Refer to paragraph 7-37.
Function-test metering valve of kit 9024718.		X			Refer to paragraph 7-38.
Proof-test hoses.				X	Every 6 months. Refer to paragraph 7-40.

Figure 7-25. Maintenance Requirements for Test Plates, Adapters, and Tools (Sheet 2 of 2)

7-30. CLEANING. The cleaning requirements for kits 9016701, 9016710, 9013711-21, 9016712-11, 9017259, 9018846, 9020269, 9024496, 9024994, 9024999, 9025424, and 9025817 are specified in step a. The cleaning requirements for all other kits are specified in step b. During cleaning procedures, clean hoses as specified in step c.

a. Clean (section I) kit components prior to use whenever cleanness level does not meet visual inspection requirements of section I. If component incorporates a burst diaphragm, refer also to paragraph 7-31.

b. Clean (section I) kit components prior to use whenever cleanness level does not meet the propellant or pneumatic service inspection requirements of section I. If component incorporates a burst diaphragm, refer also to paragraph 7-31.

c. If test plate or adapter incorporates a hose, remove hose and clean as specified in section I. Reinstall after thorough drying.

7-31. REMOVING AND INSTALLING BURST DIAPHRAGMS. Remove and install burst diaphragms by applying torque load to burst diaphragm body, not diffuser. Clean burst diaphragm as specified in section I. (Do not disassemble burst diaphragm assembly.) Lubricate threads (Method A, section I) with sealing and antiseize compound RB0140-005 (Rocketdyne). Lubricate packings (Method J, section I) with FS1281 grease (Dow Corning Corp). Install burst diaphragm and torque to 100-150 inch-pounds. Apply torque to burst diaphragm body, not diffuser. On test plates 9016746, 9020222-11, 9020223, 9020526, 9020274, 9020275, 9020528, and safetywire burst diaphragm to test plate with Inconel lockwire MS20995N.

CAUTION

Torque loads applied to the burst diaphragm diffuser can result in damage to the burst diaphragm.

7-32. LUBRICATING.

a. Lubricate (Method J, section I) all O-rings, packings, and gaskets with FS1281 grease (Dow Corning Corp).

b. Lubricate (Method A, section I) straight threads with sealing and antiseize compound RB0140-005 (Rocketdyne).

c. Lubricate (Method I, section I) pipe threads on nipple AN816-4-4C and connector 9024720 of valve 9024719 (metering valve kit 9024718) with thread sealant tape RB0140-002 (Rocketdyne).

d. Lubricate (Method C, section I) threads of jackscrew on lower bracket 9021015 of bypass valve removal tool kit 9020269 with lubricant grease RB0140-012 (Rocketdyne).

7-33. REMOVING AND INSTALLING FITTINGS, HOSES, AND VALVES. When removing and installing fittings, hoses, and valves from or onto kit components, use care to prevent deforming or damaging parts. Refer to paragraph 7-32 and apply lubricant as required. Torque parts as indicated in figure 7-26. If kit is not listed in figure 7-26, use standard torque values found in section I.

7-34. REPLACING PLASTIC FILM SEALING SURFACES. Plastic film sealing surfaces are used on the test plates in kits 9016719, 9016724, 9017273, 9017274, 9018840, 9018843-11, and 9020266. Replace plastic film as follows:

a. Remove existing plastic film from surface and clean test plate. (Refer to paragraph 7-30.)

b. Obtain a piece of 3-1/2-mil thick Teflon tape P422 (Permacel) or 549 plastic film, Type 3 GCS (Minnesota Mining and Mfg) of sufficient size to fit plate.

c. Remove protective backing from adhesive surface and apply film to test plate.

d. Press film until surface is smooth and, using a sharp knife, remove excess film from outer periphery, center hole, bolt holes, and packing groove of test plate.

7-35. REPLACING TEFLON SHEET SEALING SURFACES.

NOTE

Test plate in kit 9016701 may use rubber as a seal.

Teflon sheet sealing surfaces are used on test plates in kits 9016701, 9018846, and 9025400. Replace Teflon sheet sealing surface as follows:

a. Remove existing Teflon and cement from surface and clean affected surface. (Refer to paragraph 7-30.)

b. Obtain a piece of Teflon sheet RB0130-008 (Rocketdyne) etched on one side and of sufficient size to fit plate.

WARNING

The following specifies adhesive EC776, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the adhesive can cause serious bodily harm. In case of prolonged exposure immediately obtain fresh air and wash skin with soap and water.

c. Cement etched side of Teflon sheet to plate with adhesive EC776 (Minnesota Mining and Mfg) applied in accordance with manufacturer's instructions.

d. Using a sharp knife, remove excess Teflon sheeting from outer periphery, center hole, and boltholes, as applicable.

7-36. REPLACING RUBBER SEALS.

NOTE

Test plate in kit 9016701 may use Teflon as a seal.

Rubber seals are used on test plates in kits 9016701, 9016710, 9016713, and 9019960. Replace seals using the following steps, as applicable.

a. Remove existing rubber seal and cement and, referring to paragraph 7-30, clean affected surface.

b. Replace rubber seals of test plate 9019860-11 (hot-gas exhaust test plate kit 9016710) and test plate 9020255 (bypass duct test plate kit 9016701) as follows:

(1) Obtain a piece of 0.062-inch-thick rubber (MIL-R-3065)(SC510, ABF_1K_2) of sufficient size to fit plate (13.98 inches square).

WARNING

The following specifies cement EC1300, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the cement can cause serious bodily harm. In case of prolonged exposure immediately obtain fresh air and wash skin with soap and water.

(2) Cement seal to plate with adhesive EC1300 or EC1300L (Minnesota Mining and Mfg) in accordance with manufacturer's instructions.

c. Replace rubber seal of test plate 9019858 (turbopump inlet duct test plate kit 9016713) as follows: (Step b procedure is an allowable alternate method.)

(1) Obtain a piece of 0.060-inch-thick general purpose rubber sheet AMS 3208 of sufficient size to fit plate (10.72 inches).

(2) Using general purpose adhesive (MIL-A-5092, Type II), brush one coat of adhesive on each surface to be bonded. Allow cement to become tacky, then roll and firmly press both surfaces to remove air bubbles. (Do not allow the bond to be strained for 48 hours.)

Part Number of Kit	Test Plate or Adapter	Valve or Connector	Torque (Inch-Pounds)
9016713	9019858	Relief valve	650-900
9016719	9016746	Union	55-80
9016719	9016746	Cap	135-185
9016723-11	9020251-11	Check valve	40-65
9016723-11	9020251-11	Vent valve	40-65
9018843-11	9020222-11	Elbow	No torque required
9018843-11	9020222-11	Nut	75-100
9018846	9022823	Bushing (to Tee)	100-150
9020784-11	9020971-11	Vent valve[a]	20-25
9020784-11	9025401	Vent valve[a]	20-25
9024496	9024523	Reducer	100-150
9024496	9024523	Cap	70-80
9024497	9025379	Reducer	25-35
9024718	9024720	Connector	100 (minimum)
9024718	9024719	Nipple	55-80
9025419	9025420	Adapter	3-4
9025818	9025817	Clamp	45-50

(a) Use strap wrench on knurled surface.

Figure 7-26. Special Torque Requirements for Test Plates and Adapters

d. Replace rubber sealing surface of test plate 9019961 (accumulator hose test plate kit 9019960) as follows:

(1) Obtain a piece of 0.062-inch-thick rubber (MIL-R-3065) (SC710, ABF1K2) of sufficient size to fit plate.

(2) Using adhesive EC1300 or EC1300L (Minnesota Mining and Mfg), cement sheet to plate in accordance with manufacturer's directions.

7-36A. REPLACING PAD ON PRESSURE TRANSDUCER TORQUE WRENCH. Replace pad on transducer removal torque wrench as follows:

a. Remove existing pad and cement from wrench. Clean residual cement from bonding surface of wrench by scraping or sanding.

b. Cut a sheet of Insulcork 2755 (Armstrong Cork Co) 0.060 inch thick and of sufficient size to cover interior diameter of torque wrench clamping ring.

WARNING

The following specifies cement 910, which is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

c. Apply a coat of Eastman cement 910 to inside diameter of torque wrench clamping ring and to one side of Insulcork.

d. Assemble pad to wrench, and press cemented surfaces together to remove trapped air.

e. Install torque wrench on a section of one-inch OD tubing, and tighten wrench sufficient to extrude cement at bond line.

f. Allow 8 hours minimum curing time; then trim Insulcork to edge of torque wrench.

7-37. FUNCTION-TESTING RELIEF VALVE. Function-test relief valve RD284-5006-0500 (turbopump inlet duct test plate kit 9016713) as follows:

a. Remove relief valve from test plate.

b. Pressurize relief valve with helium that meets requirements specified in section I, and use denatured alcohol to leak-test valve as follows: (Deflector plate cover may be inverted and filled or valve may be immersed in alcohol for leak test.)

(1) Increase pressure to 45 psig. Valve must not relieve. No external leakage allowed.

(2) Increase pressure. Valve must relieve at 50 ±2.5 psig.

(3) Decrease pressure. Valve must reseal within 2.5 psig of relief pressure.

(4) Decrease pressure. Relief valve must seal off at no less than 35 psig, and there must be no external leakage (at joint between test plate and relief valve).

(5) Remove helium pressure.

c. Reinstall relief valve onto test plate, using a new gasket MS28778-16. (Refer to paragraphs 7-32 and 7-33.)

7-38. FUNCTION-TESTING METERING VALVE. The function test of metering valve assembly 9024719 (of metering valve kit 9024718) is limited to checking the valve handle for freedom of movement.

7-39. (Deleted)

7-40. PROOF-TESTING. Proof-pressure-test hoses as follows:

NOTE

Hydrostating the following hoses, or pneumostating with helium or clean air, is an acceptable alternate to testing with gaseous nitrogen; however, it is mandatory that the interior of the hoses be kept LOX-clean, or cleaned to meet acceptable LOX-clean requirements, and be thoroughly dried before reassembly.

a. Disconnect hose assembly 19-9021904-16, or 1-A-0344-0180 (Preece Inc), from test plate assembly 9025379 of augmented spark igniter and gas generator oxidizer purge line test plate kit 9024497 and apply 6,500 ±130 psig to hose 19-9021904-16 (or 6,000 ±120 psig to hose 1-A-0344-0180) for 5 minutes using gaseous nitrogen (MIL-P-27401). There must be no visible damage to hose assembly. Reassemble test plate assembly.

Figure 7-27 deleted.

b. Separate (if connected) hose assembly RD10-0060 (Culligan Inc) from adapter assembly 9024523 of oxidizer and fuel turbine drain line adapter test kit 9024496, and close free end of hose by inserting a plug or tube (with plug). (Secure plug or tube by clamping.) Apply 150 ±10 psig for 5 minutes using gaseous nitrogen (MIL-P-27401). There must be no visible damage to hose assembly.

c. Disconnect hose 19-9021904-15 from the following adapters and test plates and apply 6,500 ±130 psig using gaseous nitrogen (MIL-P-27401) for 5 minutes. There must be no visible damage to hose. Reassemble adapters and test plates.

(1) 9025420 (kit 9025419)

(2) 9025821 (kit 9024998)

(3) 9025853 (kit 9019969)

(4) 9025871 (kit 9019968)

d. Remove burst diaphragm from tee of adapter 9025818 (adapter kit 9025817), and using clamp AN737-TW48 and a suitable plug, apply gaseous nitrogen (MIL-P-27401) at 100 ±10 psig for 5 minutes. There must be no visible damage to hose. Reassemble adapter 9025318.

7-41. STORING TEST PLATES, ADAPTERS, AND TOOLS.

7-42. Store test plates, adapter, plugs, meter valve, tools, and torque wrench kits in their respective reusable containers. Make sure parts are clean before placing in container.

SECTION VIII

EXTENDED RANGE VIBRATION SAFETY CUTOFF SET G1038

WARNING

EXTENDED RANGE VIBRATION SAFETY CUTOFF SET G1038 AND VIBRATION SAFETY CUTOFF TEST SET 9024498 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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Underlined titles denote primary paragraphs.

8-1. DESCRIPTION AND LEADING PARTICULARS.

8-2. Extended Range Vibration Safety Cutoff Set G1038 monitors engine vibration during engine operation and initiates a cutoff signal when the vibration, within a preset frequency range, reaches a damaging amplitude and continues for a preset time. The set consists of a vibration safety cutoff unit, an isolator amplifier, and an accelerometer. An amplifier mounting panel is used with the set to provide mounting facilities for the isolator amplifier, and coaxial cables are fabricated with the required capacitance to interconnect the components. Figures 8-1 through 8-3 illustrate and list the leading particulars of the set. Instructions for use of the set are in R-3825-1B.

8-3. VIBRATION SAFETY CUTOFF UNIT. The vibration safety cutoff unit 9016220-11 (figure 8-1) is a solid-state, rack-mounted electronic unit designed to monitor amplified thrust chamber accelerometer signals and initiate engine cutoff to prevent damage to or destruction of the engine. The unit has three indicator lights, two fuse holders, three switches, five potentiometers, a headphone jack, and four test jacks mounted on the front panel. Twelve test jacks and two receptacles are mounted on the rear of the chassis. The chassis houses five electronic component boards, a band-pass filter, three relays, a transformer, and various other electronic components. The power input and remote-control signals enter through receptacle J1; the amplified accelerometer signal enters through receptacle J3. Figure 8-2 lists leading particulars for the vibration safety cutoff unit.

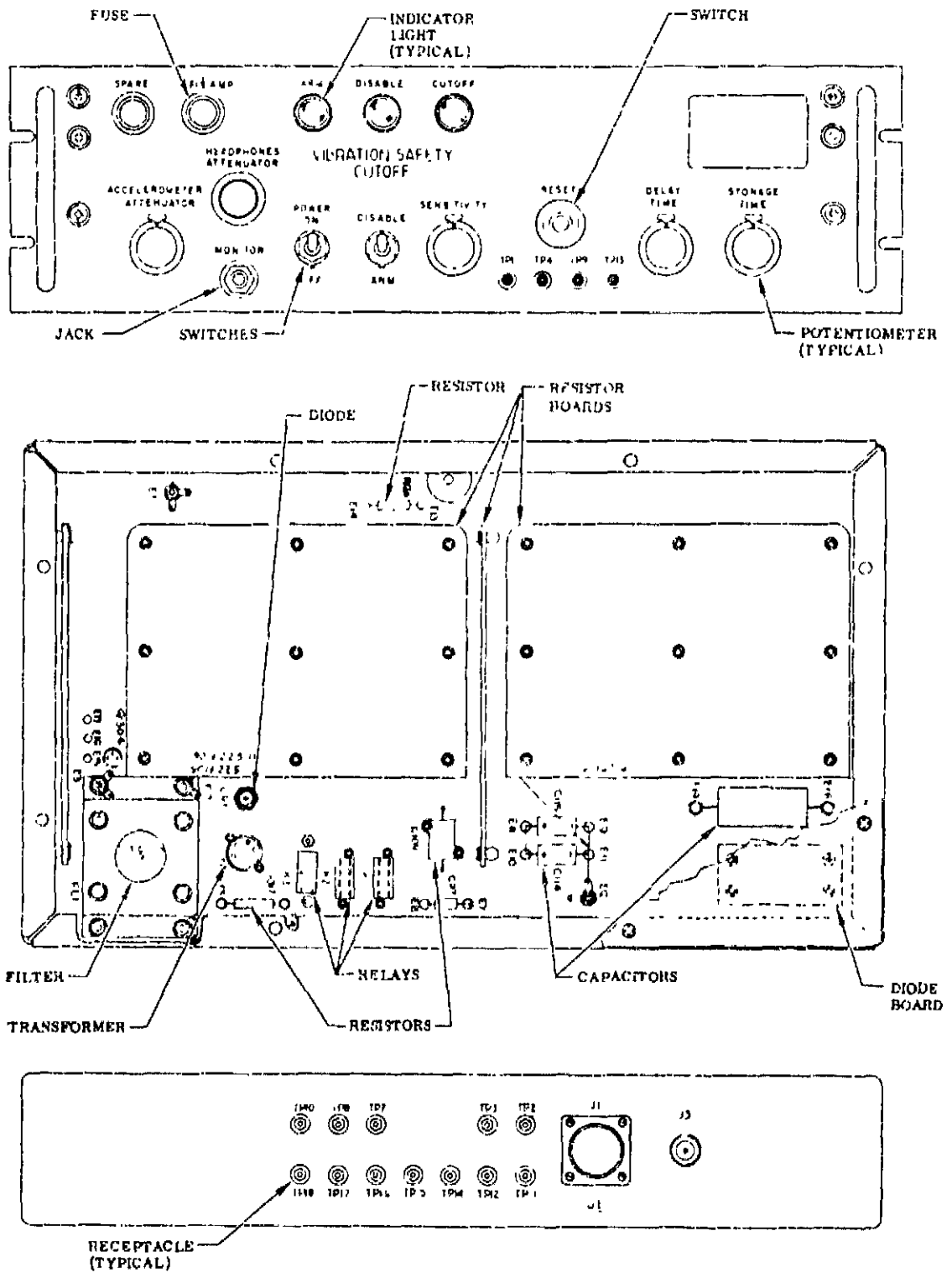


Figure 8-1. Vibration Safety Cutoff Unit

Dimensions	
Height	5.25 inches
Width	19 inches
Depth	10 inches
Requirements	
Power Input	28 ±4 vdc at 370 milli-amperes
Performance	
Sensitivity	25 millivolts rms minimum (using a 4.6 or 5 mv/g accelerometer)
Frequency range	960 to 6,000 cps band-pass
Time delay	10-150 milliseconds, ±10%
Time storage	350-500 milliseconds, ±10% (Storage time decays exponentially.)
Output	3 single-pole double-throw relay contacts, current rating 2 amperes resistive load
Input Impedance Signal	6,000 ohms minimum resistive load

Figure 8-2. Leading Particulars for Vibration Safety Cutoff Unit

Dimensions	
Height	5.25 inches
Width	2.88 inches
Depth	13.5 inches
Requirements	
Input power	120 ±10 vac at 20 watts, 60 cps
Input impedance signal	100 megohms or greater parallel with 12 picofarads (including input filter)
Performance	
Gain	0, 0.5, 1, 2.5, 5, and 10
Variable gain	0 to 2.5 multiplier
Output impedance	Variable 20-120 ohms in series with 70 microfarads
Output voltage	10-volt peak maximum into 20,000 ohms and 0.04 microfarad load up to 10,000 cps

Figure 8-3. Leading Particulars for Isolator Amplifier

8-4. ISOLATOR AMPLIFIER. The isolator amplifier, A-C Amplifier, Model 6163 (Dynamics Instrumentation Co), is a solid-state, fully isolated, low-noise, ac amplifier that has an integral double-shielded power supply and is designed to amplify the usable accelerometer signal for transmission to the vibration safety cutoff unit via a coaxial cable of the correct capacitance. The complex signals from the accelerometer are often of a nature to cause transmission line reflections capable of causing improper operations of the cutoff set. These signals are excluded within the amplifier input by filtering part of the amplifier circuitry. The amplifier has a power switch and indicator light, a GAIN selector switch, three potentiometers (two have recessed, slotted shafts), a ZERO MONITOR test jack, a handle, and a panel-securing knob on its front panel. Two slots through the front panel provide chassis ventilation. The chassis contains two circuit boards, a diode board, a resistor board, a transformer and capacitors. An 18-contact, plug-in, male connector is mounted on the rear of the chassis for connection to the amplifier mounting panel. For more detailed information on the isolator amplifier, refer to Operating and Maintenance Manual for Dynamics A-C Amplifier, Model 6163 (Dynamics Instrumentation Co). (See figure 8-3 for leading particulars for the isolator amplifier.)

8-5. AMPLIFIER MOUNTING PANEL. The isolator amplifier is mounted in 6-position amplifier mounting panel 3024500, which provides a facility connection, separate power fuses for each amplifier, and a blower for cooling the amplifiers. Description and maintenance data for the amplifier mounting panel is in R-3825-5, Volume II, section XV.

8-6. ACCELEROMETER. The engine-mounted vibration-detecting accelerometer, Model ES-6011, ES-6412A, or ES-6412 (Electra Scientific Corp), is a piezoelectric oscillator which converts mechanical vibrations into electrical signals. The accelerometer is hermetically sealed and is designed with a coaxial connector and a 1/4 x 28 mounting stud. The acceptable alternate accelerometers to Model ES-6011 (Models ES-6412A and ES-6412) are different from Model ES-6011 and from each other in internal construction. Models ES-6011 and ES-6412A have an internal capacitance of 1,600-2,200 picofarads. Model ES-6412 has an internal capacitance of 1,100-1,450 picofarads. See figure 8-4 for leading particulars.

Operational	
Voltage sensitivity (at 100 cps into 1,650 picofarads)	5 peak millivolts/peak g minimum(a) 4.6 peak millivolts/peak g minimum(b)
Frequency response (at 100 cps)	±5% 10 to 5,000 cps (+15%, -5%) 10 to 10,000 cps
Transverse axis sensitivity	2% maximum(a) 1% maximum(b)
Internal capacitance	1,100 to 1,450 picofarads(a) 1,600 to 2,200 picofarads(b)
Mounted first resonance	30 kilocycles, minimum
Internal resistance	50 megohms minimum
Insulation resistance	50 megohms minimum
Environmental	
Temperature range	-300° F to +500° F
Acceleration Range	
Vibration	3,500 g's peak
Shock (500 microseconds half-sine pulse)	10,000 g's
Sensitivity deviation (at 100 cps into 1,650 picofarads) versus temperature	Will not deviate more than 3% to -17% the room temperature sensitivity over temperature range of -50° to +350° F.
Acoustic noise response	1.0 equivalent g (rms) maximum at 150 decibels (50 to 10,000 cps white noise)
Amplitude lincarity	1% maximum from best straight line
Construction	Hermetically sealed by glass-to-metal seal and all-heliarc-welded construction.(a)
	Hermetically sealed by aluminum-to-metal seal and all-heliarc-welded construction.(b)
Electrical Connection	Accepts connector C5-P or C5-PA (Glennite)
Mounting Stud (integral)	
Thread	1/4 x 28 inches
Length	0.355 to 0.375 inches

(a) Model ES-6412
(b) Model ES-6011 or ES-6412A

Figure 8-4. Leading Particulars for Accelerometer

8-7. COAXIAL CABLES. Three separate low-noise type coaxial cables (MIL-C-17) are required to interconnect the accelerometer, isolator amplifier, and vibration safety cutoff unit. The coaxial cables connecting the accelerometer to the isolator amplifier represent a capacitance load to the accelerometer and must not exceed a total capacitance of 1,650 ±30 picofarads. The effect is to form a voltage divider at the accelerometer output, and this is shown schematically in figure 8-5. The equation in figure 8-5 is for reference information and is used only to calculate capacitance values. Total capacitance of the cable connecting the isolator amplifier to the vibration safety cutoff unit must not exceed 0.040 microfarads. Maximum length of the cable attached to the accelerometer is 4 feet. Coaxial cables provide shield protection for the signal conductor to prevent loss of the low-level signal and to prevent introduction of induced signals from other sources. The shield of the coaxial cable also provides a continuous single-ended signal return ground for the accelerometer, isolator amplifier, and vibration safety cutoff unit. Insulation is required around the coaxial shield to prevent contact with the earth ground, which could set up potential gradients along the shielding and permit introduction of unwanted signals and feedback circuits.

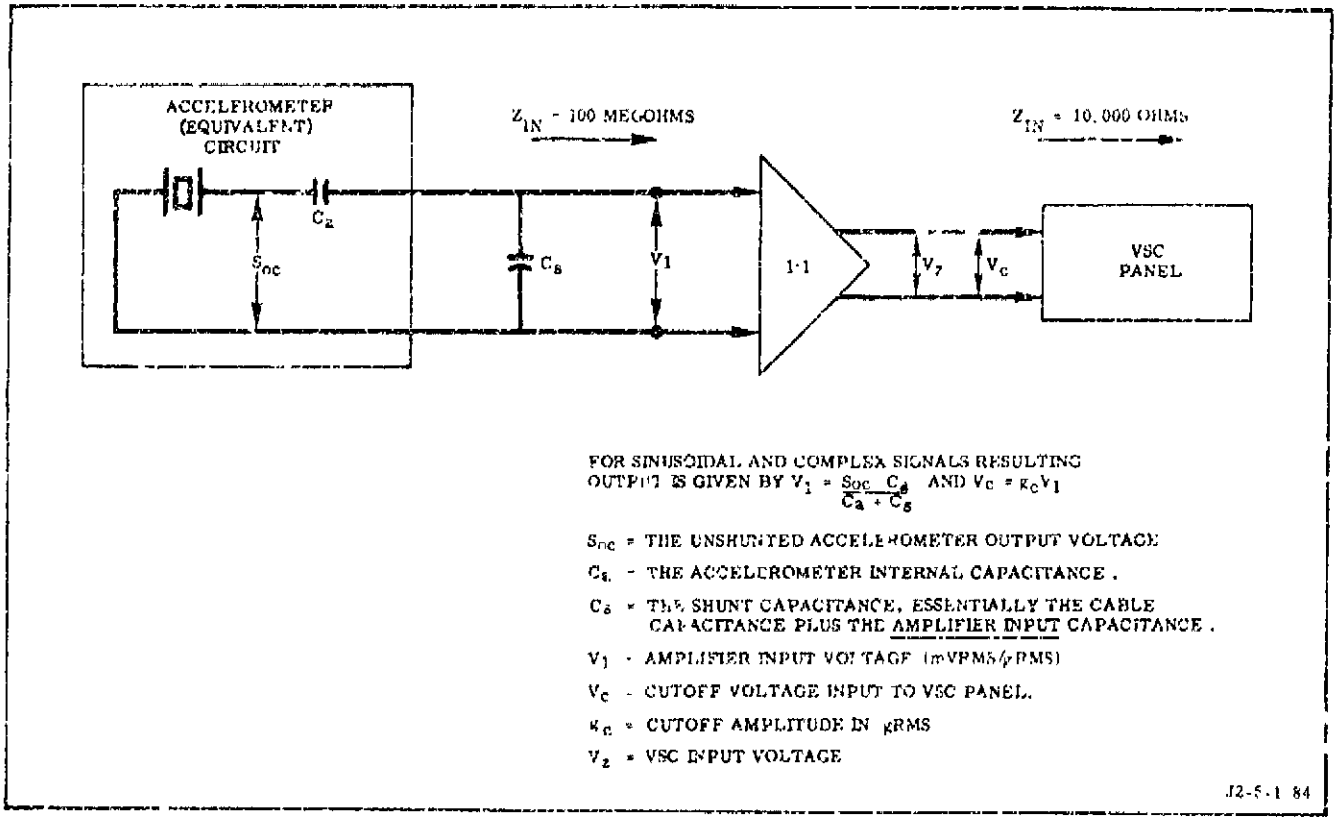

ACCELEROMETER (EQUIVALENT) CIRCUIT
Z_{IN} = 100 MEGOHMS
Z_{IN} = 10,000 OHMS
C_a
S_{oc}
C_s
V_1
1-1
V_7
V_c
VSC PANEL
FOR SINUSOIDAL AND COMPLEX SIGNALS RESULTING OUTPUT IS GIVEN BY $V_1 = \frac{S_{oc} C_s}{C_a + C_s}$ AND $V_c = K_c V_1$
S_{oc} = THE UNSHUNTED ACCELEROMETER OUTPUT VOLTAGE
C_a = THE ACCELEROMETER INTERNAL CAPACITANCE.
C_s = THE SHUNT CAPACITANCE, ESSENTIALLY THE CABLE CAPACITANCE PLUS THE AMPLIFIER INPUT CAPACITANCE.
V_1 = AMPLIFIER INPUT VOLTAGE (mVRMS/μRMS)
V_c = CUTOFF VOLTAGE INPUT TO VSC PANEL.
K_c = CUTOFF AMPLITUDE IN μRMS
V_2 = VSC INPUT VOLTAGE
J2-5-1 84

Figure 8-5. Accelerometer Output Equation

8-8. THEORY OF OPERATION.

8-9. The vibration safety cutoff set is an electronic system designed to automatically cut off the engine in the event of excessive engine vibration during a ground test. The vibration is detected by the accelerometer, which produces a voltage proportional to the amplitude of the vibration at the vibration frequency. (See figure 8-6 for signal flow.) The accelerometer signal is applied to the isolator amplifier, where the impedance level is changed from high input to low output to drive the transmission line and provide the input signal to the vibration safety cutoff unit. Within this unit, the input signal passes into an emitter follower which furnishes a low output impedance to drive the filter and headphone amplifier. The signal is unchanged in waveform as it enters the bandpass filter. The filter removes frequencies below 960 cps and above 6,000 cps. The filter output, now changed in waveform due to frequency discrimination, is amplified by the variable gain amplifier and set-up transformer. The trigger circuits sense the peak amplitude of the incoming signal and, if it exceeds a predetermined amplitude, produce pulses. One trigger circuit produces a positive pulse and the other a negative pulse, and the two pulses are added together by the adder (OR gate). Since the two pulses are 180 degrees out of phase, dc output voltage results. The dc output signal from the adder activates the timer, which produces an output linearly increasing with time. After a given time delay, the output reaches the trigger level of the output switch which energizes the cutoff relay. The output switch holds the relay energized until reset. The vibration safety cutoff unit may be controlled automatically and remotely by means of the reset and disable relays. The unit may be disabled during any portion of a ground test to prevent a cutoff due to vibration transients. In a ternary installation, the cutoff relay contacts of three vibration safety cutoff units are interconnected as shown in figure 8-8. This interconnection requires that the cutoff relay contacts of any two of the three vibration safety cutoff units must be actuated to initiate engine cutoff. In addition, a failure (false cutoff signal or failure to obtain a cutoff signal) of any one of the three units will not result in engine cutoff nor will it inhibit a valid cutoff of the engine by the other two units.

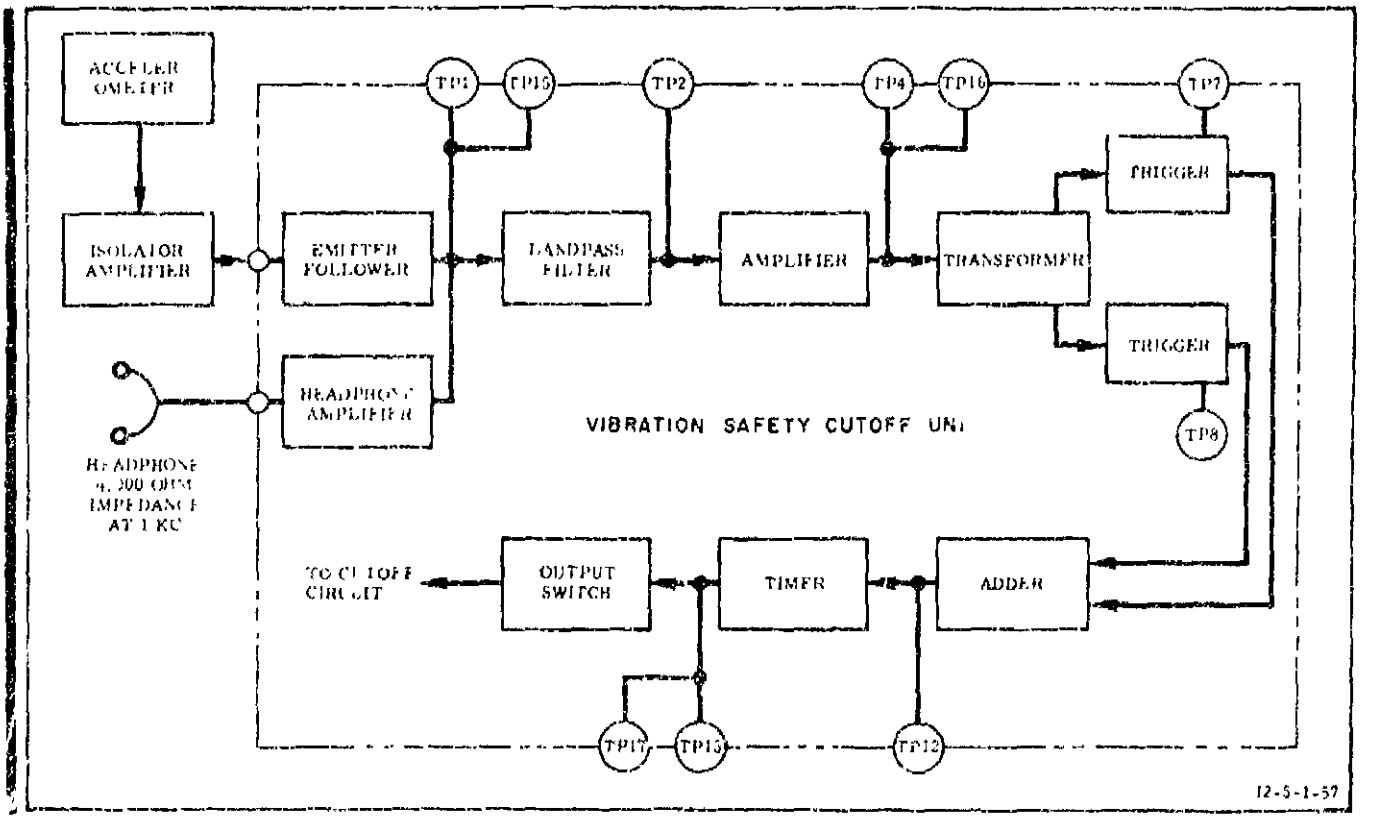


Figure 8-6. Signal Flow Block Diagram

8-10. INSTALLING SET IN TEST FACILITY.

8-11. The vibration safety cutoff set components are installed in separate locations and interconnected by coaxial cables. The cutoff unit is installed in the control center, the isolator amplifier is installed in a terminal house (cubicle) near the engine, and the accelerometer is mounted on the engine thrust chamber dome. Requirements for fabrication of interconnecting coaxial cables are given in paragraph 8-15. After installing the vibration safety cutoff set, an interconnect verification test and a preoperation and calibration test are performed.

8-12. INSTALLING VIBRATION SAFETY CUTOFF UNIT. The cutoff unit must be function tested prior to installation. Refer to paragraph 8-26. Install cutoff unit in a standard 19-inch rack in control center. See figure 8-7 or 8-8 as an aid in installation.

8-13. INSTALLING ISOLATOR AMPLIFIER. The isolator amplifier is mounted in the amplifier mounting panel.

a. Install amplifier mounting panel in a standard 19-inch rack.

b. Insert isolator amplifier into panel and make sure that coaxial connectors are properly alined.

c. Connect panel power supply cable to 120 ±10 vac, 60-cps facility supply.

8-14. INSTALLING ACCELEROMETER. Information for installing accelerometer is in R-3825-1B.

8-15. FABRICATING AND INSTALLING CABLES. Fabricate accelerometer, isolator amplifier input, vibration safety cutoff unit, and input power and control signal cables. See

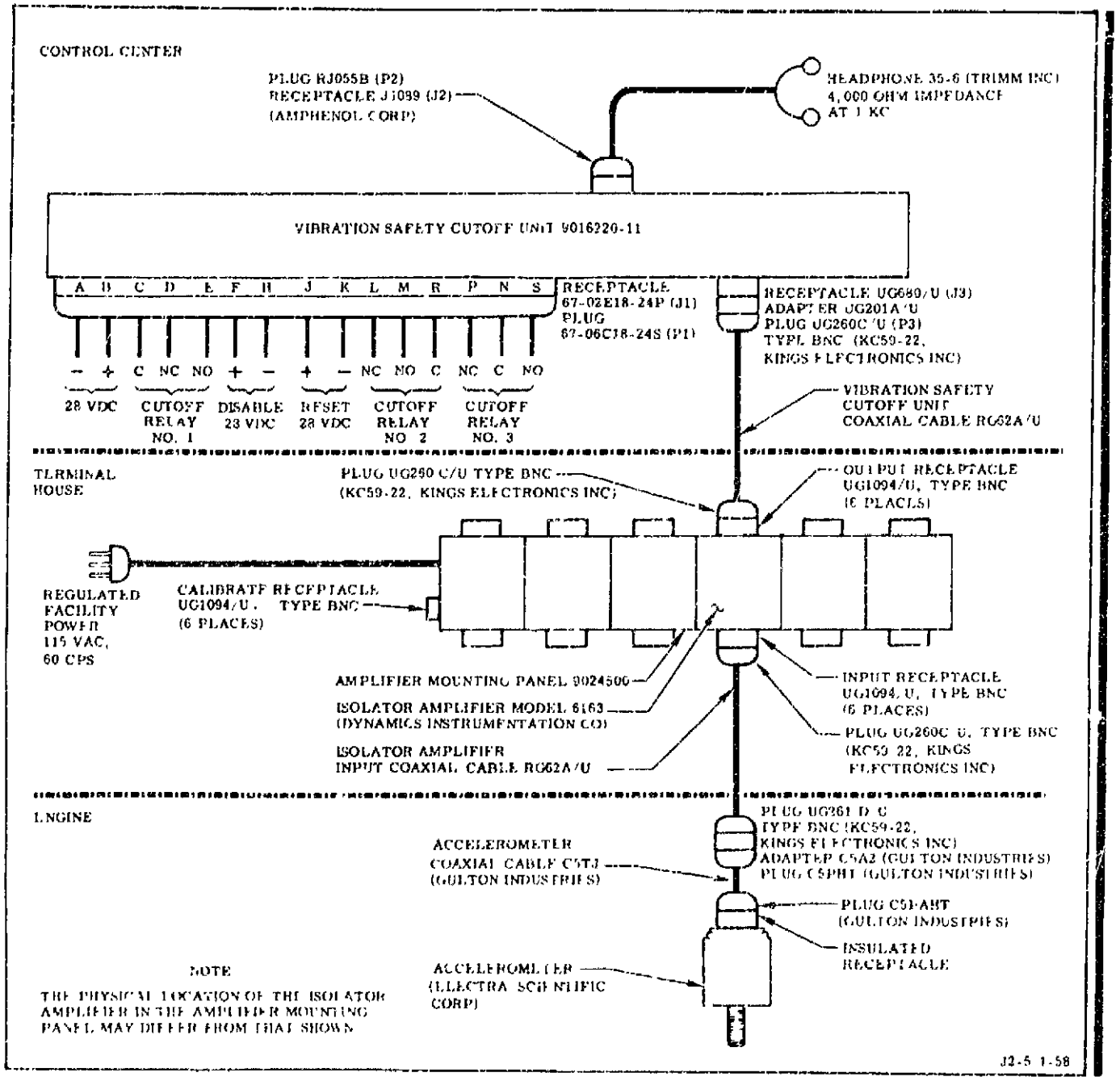

CONTROL CENTER
PLUG RJ055B (P2)
RECEPTACLE J1099 (J2)
(AMPHENOL CORP)
HEADPHONE 35-6 (TRIMM INC)
4,000 OHM IMPEDANCE
AT 1 KC
VIBRATION SAFETY CUTOFF UNIT 9016220-11
A B C D E F H J K L M R P N S
RECEPTACLE
67-02E18-24P (J1)
PLUG
67-06C18-24S (P1)
RECEPTACLE UG680/U (J3)
ADAPTER UG201A/U
PLUG UG260C/U (P3)
TYPE BNC (KC59-22,
KINGS ELECTRONICS INC)
- + C NC NO + - + - NC NO C NC C NO
28 VDC
CUTOFF RELAY NO. 1
DISABLE 28 VDC
RESET 28 VDC
CUTOFF RELAY NO 2
CUTOFF RELAY NO. 3
VIBRATION SAFETY CUTOFF UNIT COAXIAL CABLE RG62A/U
TERMINAL HOUSE
PLUG UG260 C/U TYPE BNC
(KC59-22, KINGS ELECTRONICS INC)
OUTPUT RECEPTACLE UG1094/U, TYPE BNC (6 PLACES)
REGULATED FACILITY POWER 115 VAC, 60 CPS
CALIBRATE RECEPTACLE UG1094/U, TYPE BNC (6 PLACES)
AMPLIFIER MOUNTING PANEL 9024500
ISOLATOR AMPLIFIER MODEL 6163 (DYNAMICS INSTRUMENTATION CO)
ISOLATOR AMPLIFIER INPUT COAXIAL CABLE RG62A/U
INPUT RECEPTACLE UG1094/U, TYPE BNC (6 PLACES)
PLUG UG260C/U, TYPE BNC (KC59-22, KINGS ELECTRONICS INC)
ENGINE
PLUG UG261/U
TYPE BNC (KC59-22, KINGS ELECTRONICS INC)
ADAPTER C5A2 (GULTON INDUSTRIES)
PLUG C5PHT (GULTON INDUSTRIES)
ACCELEROMETER COAXIAL CABLE C5TJ (GULTON INDUSTRIES)
PLUG C5PAHT (GULTON INDUSTRIES)
INSULATED RECEPTACLE
ACCELEROMETER (ELECTRA SCIENTIFIC CORP)
NOTE
THE PHYSICAL LOCATION OF THE ISOLATOR AMPLIFIER IN THE AMPLIFIER MOUNTING PANEL MAY DIFFER FROM THAT SHOWN
J2-5 1-58

Figure 8-7. Installation Schematic

figure 8-9 for required capacitance, connectors, and suggested coaxial cables. See figure 8-7 or 8-8 for cable installation schematic. Use a capacitance bridge with a range of 1,000-50,000 (10) picofarads to verify that cable capacitance values are equal to values in figure 8-9. Connect cables. Secure cables to prevent vibration, which can cause unnecessary signals (hammering). The accelerometer cable must not be twisted during installation and must not be attached to any surface that can have temperatures lower than 32° F or higher than 150° F.

CAUTION

Twisting of accelerometer cable during installation and securing can cause damage to cable.

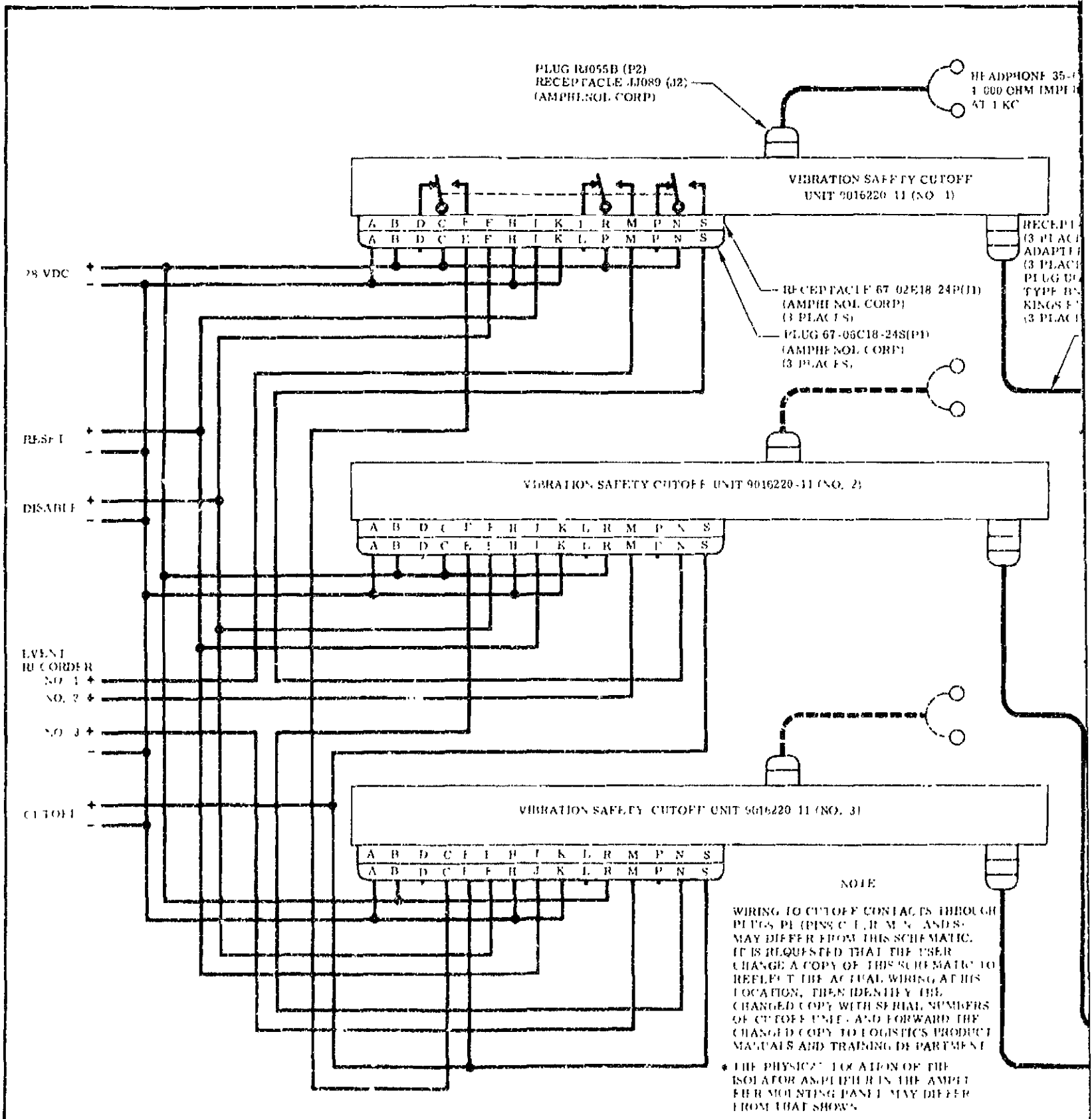
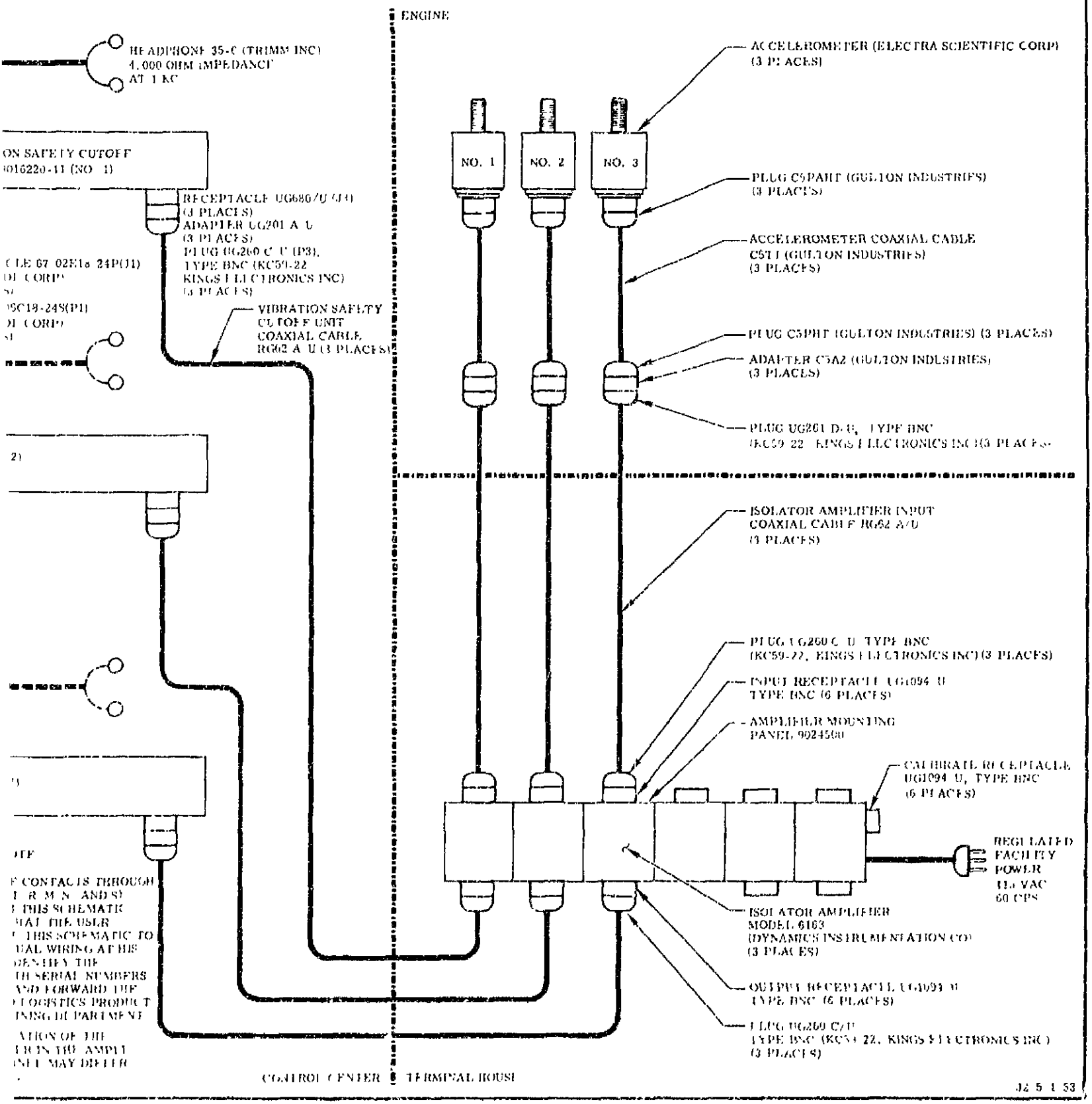

PLUG RJ055B (P2)
RECEPTACLE JJ089 (J2)
(AMPHENOL CORP)
HEADPHONE 35-
1 000 OHM IMPE
AT 1 KC
VIBRATION SAFETY CUTOFF
UNIT 9016220 11 (NO 1)
A B D C E F H J K L R M P N S
A B D C E F H J K L P M P N S
28 VDC
RECEPTACLE 67 02E18 24P(J1)
(AMPHENOL CORP)
(3 PLACES)
PLUG 67-06C18-24S(P1)
(AMPHENOL CORP)
(3 PLACES)
RESET
DISABLE
VIBRATION SAFETY CUTOFF UNIT 9016220-11 (NO. 2)
EVENT
RECORDER
NO. 1
NO. 2
NO. 3
CUTOFF
VIBRATION SAFETY CUTOFF UNIT 9016220 11 (NO. 3)
NOTE
WIRING TO CUTOFF CONTACTS THROUGH
PLUGS P1 (PINS C L R M N AND S)
MAY DIFFER FROM THIS SCHEMATIC.
IT IS REQUESTED THAT THE USER
CHANGE A COPY OF THIS SCHEMATIC TO
REFLECT THE ACTUAL WIRING AT HIS
LOCATION, THEN IDENTIFY THE
CHANGED COPY WITH SERIAL NUMBERS
OF CUTOFF UNIT AND FORWARD THE
CHANGED COPY TO LOGISTICS PRODUCT
MANUALS AND TRAINING DEPARTMENT
* THE PHYSICAL LOCATION OF THE
ISOLATOR AMPLIFIER IN THE AMPLI
FIER MOUNTING PANEL MAY DIFFER
FROM THAT SHOWN

Figure 8-8. Ternary Vibration Safety Cutoff Installation Schematic


ENGINE
HEADPHONE 35-C (TRIMM INC)
4,000 OHM IMPEDANCE
AT 1 KC
ON SAFETY CUTOFF
016220-11 (NO 1)
RECEPTACLE UG680/U (J1)
(3 PLACES)
ADAPTER UG201 A U
(3 PLACES)
PLUG UG260 C U (P3),
TYPE BNC (KC59-22
KINGS ELECTRONICS INC)
(3 PLACES)
VIBRATION SAFETY
CUTOFF UNIT
COAXIAL CABLE
RG62 A U (3 PLACES)
ACCELEROMETER (ELECTRA SCIENTIFIC CORP)
(3 PLACES)
NO. 1
NO. 2
NO. 3
PLUG C5PAHT (GULTON INDUSTRIES)
(3 PLACES)
ACCELEROMETER COAXIAL CABLE
C5T1 (GULTON INDUSTRIES)
(3 PLACES)
PLUG C5PHT (GULTON INDUSTRIES) (3 PLACES)
ADAPTER C5A2 (GULTON INDUSTRIES)
(3 PLACES)
PLUG UG201 D/U, TYPE BNC
(KC59-22 KINGS ELECTRONICS INC) (3 PLACES)
ISOLATOR AMPLIFIER INPUT
COAXIAL CABLE RG62 A/U
(3 PLACES)
PLUG UG260 C U TYPE BNC
(KC59-22, KINGS ELECTRONICS INC) (3 PLACES)
INPUT RECEPTACLE UG1094 U
TYPE BNC (6 PLACES)
AMPLIFIER MOUNTING
PANEL 9024500
CALIBRATE RECEPTACLE
UG1094 U, TYPE BNC
(6 PLACES)
REGULATED
FACILITY
POWER
115 VAC
60 CPS
ISOLATOR AMPLIFIER
MODEL 6163
(DYNAMICS INSTRUMENTATION CO)
(3 PLACES)
OUTPUT RECEPTACLE UG1093 U
TYPE BNC (6 PLACES)
PLUG UG260 C/U
TYPE BNC (KC59-22, KINGS ELECTRONICS INC)
(3 PLACES)
CONTROL CENTER & TERMINAL HOUSI
Jul 5 1 53

Cable Name	Coaxial (MIL-C-17)	Capacitance/ft (Picofarads)	Connector Cable End	Connector Cable End
Accelerometer	C-5TJ(a)(b)(c)	38	Accelerometer C5-PAHT	Adapter C5A2 C5-PHT
Isolator amplifier input	RG62A/U(a)(e)	13.5	Adapter C5A2 UG261 D/U(g)	Amplifier UG260 C/U(g)
Vibration safety cutoff unit	RG62A/U(a)(d)(e)	13.5	Amplifier output UG260 C/U(g)	Unit receptacle J3 (UG201 A/U adapter) UG260 C/U(g)
Input power cable and control signal cable			Unit plug P1(f) 67-06C18-24S	

(a) Low-noise type
(b) Maximum length is 4 feet.
(c) Total capacitance of accelerometer cable and isolator amplifier cable must not exceed 1,650 ±30 picofarads.
(d) Total capacitance of cable must be 0.040 picofarads maximum.
(e) When amplifier output signal is monitored or recorded, the monitoring or recording device input circuit must be isolated from the power systems ground to make sure of proper operation.
(f) Supplied with panel.
(g) Type BNC (KC59-22 Kings)

Figure 8-9. Cable Fabrication Requirements

8-16. RECORDER REQUIREMENTS. Three recorder channels must be used to obtain the minimum required information. If the isolator amplifier output signal (vibration safety cutoff unit input signal) is monitored or recorded, the monitoring device input circuit must be isolated from the power system grounds for proper operation. Additional recorder channels are required to accommodate the ternary cutoff installation. These recording channels must be monitored at the following points: TP1 (unfiltered emitter follower), TP12 (timer output), and pin E of receptacle J1. Additional information may be obtained by connecting another recorder channel at test point TP4 (filtered amplifier output). Excessive loading of any test point changes the circuit characteristics when taking signals from those test points. Test point TP13 is most sensitive to the resistive load and should not have less than 5 megohms between it and ground. The shunt capacitance at test points 1 and 4 must not exceed 300 picofarads. Figure 8-10 outlines the allowable values of resistive load on each critical test point and the approximate signal level at each test point at the critical cutoff level.

Test Point	Approximate Signal Amplitude	Resistance, Minimum
TP1 or TP15	$2.1-\frac{x}{500}$ / $10.8-\frac{x}{167}$	20K
TP2	Same as TP1	100K
TP4(a) or TP16(a)	1 vac (rms)	10K
TP7	16 vdc	100K
TP8	16 vdc	100K
TP12	16 vdc	100K
TP13 or TP17	8 vdc	5M

x = dial setting of SENSITIVITY CONTROL
(x = 1,000 when SENSITIVITY CONTROL is fully clockwise)
(x = 0 when SENSITIVITY CONTROL is fully counterclockwise)

(a) Shunt capacitance at TP4 makes amplifier susceptible to oscillation. To eliminate this condition, connect a 2K resistor directly at test point. Value in figure may be used.

Figure 8-10. Test Points Resistive Loads

8-17. MAINTENANCE, TESTING, REPAIR, AND STORAGE REQUIREMENTS FOR EXTENDED RANGE VIBRATION SAFETY CUTOFF SET G1038.

8-18. Maintenance tasks required to keep the extended range vibration safety cutoff set in a serviceable condition are listed in figure 8-11. After installation of extended range vibration safety cutoff sets (ternary installation), an interconnect verification test must be accomplished in accordance with paragraph 8-23. After installation of extended range vibration safety cutoff sets and any time a change in a g-level or timing occurs, a preoperation and calibration test and preoperation tap test must be accomplished in accordance with paragraphs 8-24 and 8-25. Also, prior to engine operation a preoperation cutoff test and a preoperation tap test must be accomplished in accordance with procedures in R-3825-1B. A function test of the vibration safety cutoff unit must be accomplished whenever a unit is repaired or modified or whenever a malfunction is suspected.

8-19. MAINTENANCE REQUIREMENTS.

8-20. Maintenance tasks required on the extended range vibration safety cutoff set are listed in figure 8-11. Information presented lists the tasks to be performed, when the tasks must be performed, and references to data necessary to accomplish these tasks.

Requirements	Receiving	Prior to Use	Storage	Special	Remarks
Inspect set for completeness.	X	X			Refer to paragraph 8-2.
Inspect vibration safety cutoff unit for:	X	X			See figure 8-18.
Damaged receptacles.					Replace damaged receptacle.
Broken or frayed wiring insulation.					Replace wire.
Inspect receptacle J3 for security.		X			Torque receptacle sleeve to 40-50 inch-pounds.
Inspect painted portion of vibration safety cutoff unit.				X	Whenever painted surfaces are damaged. Paint with enamel (Federal Specification TT-E-529); color 26440 (Federal Standard 595).
Install protective caps or dummy receptacles.				X	Whenever receptacles are not in use.
Perform preoperation and calibration test.				X	After installation and whenever a component is replaced or a change in operating g level or timing occurs. Refer to paragraph 8-24.

Figure 8-11. Maintenance Requirements (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Remarks
Function-test vibration safety cutoff unit.				X	Prior to installation, every 6 months and whenever unit is repaired, modified, or a malfunction is suspected. Refer to paragraph 8-26.
Test vibration safety cutoff unit DC voltage level.				X	When required to isolate a malfunction. Refer to paragraph 8-27.
Calibrate vibration safety cutoff unit.				X	Every 6 months and whenever the differences in calibration values between the dial setting chart (figure 8-19) and the calibration-test check form (figure 8-10) are greater than 5 percent, and whenever malfunction is suspected. Refer to paragraph 8-28.
Calibrate accelerometer.				X	Every 6 months, after 2,500 seconds of operation, 10 engine tests, and whenever cutoff occurs from vibration, data indicates instability, or damage is suspected. Refer to paragraph 8-29.
Prepare for storage.				X	Whenever set is removed from instrumentation room and is not in use. Refer to paragraph 8-40.

Figure 8-11. Maintenance Requirements (Sheet 2 of 2)

8-21. TESTING.

8-22. Testing the extended range vibration safety cutoff set consists of various tests to verify correct interconnection of components, establish the specific settings at which the set operates, verify proper functioning of the vibration safety cutoff unit, verify proper dc voltage level at specific points in the vibration safety cutoff unit, verify accelerometer attenuator and sensitivity control dial settings, and calibrate and check accelerometer.

8-23. INTERCONNECT VERIFICATION TEST. After installation of a ternary vibration safety cutoff system, the following test must be accomplished to verify correct interconnection of system components.

a. Obtain a signal generator and an ac voltmeter as listed in figure 8-12.

b. Designate vibration safety cutoff units and isolator amplifiers as No. 1, No. 2, and No. No. 3.

c. Move power switches on all 3 vibration safety cutoff units and isolator amplifiers to ON, and allow 15 minutes for temperature stabilization.

d. Depress reset switch on all 3 vibration safety cutoff units.

e. Move DISABLE-ARM switch to ARM on all 3 vibration safety cutoff units.

f. Disconnect accelerometer cable from input connector on each of the 3 isolator amplifiers.

g. Accomplish the following steps on vibration safety cutoff units No. 1, No. 2, and No. 3, one at a time:

(1) Connect a signal generator and an ac voltmeter to isolator amplifier input connector. Set signal generator output frequency at 2,000 ±20 cps and output voltage at 1 volt rms ±10 percent. The CUTOFF light should come on, the ARM light should go OFF, and engine cutoff

should not be obtained. The respective event recorder should indicate cutoff, however, with the input signal applied.

NOTE

The ac voltmeter must have a minimum range of 0.10 to 3.00 volts rms, a minimum accuracy of 2 percent of reading, and a minimum input impedance of one megohm.

(2) Decrease signal generator output voltage to a value less than 0.25 volt rms.

(3) Depress vibration safety cutoff unit RESET switch. CUTOFF light must go off and ARM light must come on. Event recorder must not indicate cutoff.

(4) Deenergize signal generator. Disconnect signal generator and ac voltmeter from isolator amplifier.

Power supply	28 ±1 vdc, current capacity of 0.1 ampere
Signal generator	50-20,000 cps minimum frequency range, variable output of 0.03-3.0 volts rms minimum range (with less than 3 percent distortion at 3.0 volts rms output into a minimum load of one megohm)
DC voltmeter	0.4 volts, ±16 volts, and ±28 volts, accuracy of ±3 percent of reading, minimum sensitivity of 20,000 ohms per volt
DC voltmeter	0.010-10 volts, accuracy of ±3 percent
AC voltmeter	0.001-10.0 volts rms, accuracy of ±0.5 percent of reading. (The voltmeter must have minimum input impedance of one megohm and maintain the required accuracy over the frequency range of 100-20,000 cps.)
Oscilloscope	Model 535A (Tektronix Inc.), or equivalent, with a dual-trace plug-in unit
Vibration safety cutoff test set	9024498
Power input cable and power input receptacle to mate with test set connector P5	Part number 7427 (Harvey Hubbell Inc)
Resistor	5-megohm, ±5 percent tolerance, 1/8-watt
Voltohmmeter	630A (Triplett), or equivalent
Digital counter	12,000 cps (with readout of ±1 cps and sensitivity of 0-0.25 volt minimum)
High-impedance headphone	4,000 ohms at one kilocycle. Phone plug PJ-055B (MIL-P-642).

Figure 8-12. Test Equipment Required for Preoperation- and Calibration-Test

h. Connect a signal generator and an ac voltmeter to isolator amplifier input connector of vibration safety cutoff units No. 1 and No. 2 only, using a T-connector. Set signal generator output frequency at 2,000 ±20 cps and output voltage at 1 volt rms ±10 percent.

i. Engine cutoff signal should be obtained by test stand electrical system. CUTOFF light must come on and ARM light must go off on vibration safety cutoff units No. 1 and No. 2. Both event recorders must indicate cutoff.

j. Deenergize signal generator and disconnect T-connector from vibration safety cutoff units No. 1 and No. 2.

k. Depress No. 1 and No. 2 vibration safety cutoff unit RESET switches. CUTOFF lights must go off and ARM lights must come on. Event recorders must not indicate cutoff.

l. Connect a signal generator and an ac voltmeter to isolator amplifier input connector of vibration safety cutoff units No. 1 and No. 3 only, using a T-connector. Set signal generator output frequency at 2,000 ±20 cps and output voltage at 1 volt rms ±10 percent.

m. Engine cutoff signal should be obtained by test stand electrical system. CUTOFF light must come on and ARM light must go off on vibration safety cutoff units No. 1 and No. 3. Both event recorders must indicate cutoff.

n. Deenergize signal generator and disconnect T-connector from vibration safety cutoff units No. 1 and No. 3.

o. Depress No. 1 and No. 3 vibration safety cutoff unit RESET switches. CUTOFF lights must go off and ARM lights must come on. Event recorders must not indicate cutoff.

p. Connect a signal generator and an ac voltmeter to isolator amplifier input connector of vibration safety cutoff units No. 2 and No. 3 only, using a T-connector. Set signal generator output frequency at 2,000 ±20 cps and output voltage at 1 volt rms ±10 percent.

q. Engine cutoff signal should be obtained by test stand electrical system. CUTOFF light must come on and ARM light must go off on vibration safety cutoff units No. 2 and No. 3. Both event recorders must indicate cutoff.

r. Deenergize signal generator and disconnect T-connector from vibration safety cutoff units No. 2 and No. 3.

s. Depress No. 2 and No. 3 vibration safety cutoff unit RESET switches. CUTOFF lights must go off and ARM lights must come on. Event recorders must not indicate cutoff.

t. Reconnect accelerometer cables to input connector on each of the 3 isolator amplifiers.

u. Move DISABLE-ARM switch to DISABLE on all 3 vibration safety cutoff units.

v. Move power switches on all 3 vibration safety cutoff units and isolator amplifiers to OFF.

8-24. PREOPERATION- AND CALIBRATION-TESTING. The preoperation and calibration test establishes the specific setting at which the vibration safety cutoff set operates after installation and during engine ground tests. The test must also be performed whenever a change in g level or timing occurs. In a ternary installation, each vibration safety cutoff unit must be tested individually. The test procedures must be performed in the order in which they appear. The results obtained during calibration should be recorded on the suggested form illustrated in figure 8-13. The form is used for reference to make sure that the settings of the vibration safety cutoff set have not been changed since the last calibration test. (See figure 8-14 for preoperation and calibration test and figure 8-12 for test equipment required to perform tests on the vibration safety cutoff set.)

Calibration-Test Check Form

T-HOUSE

Vibration safety cutoff set No. _____

Test stand _____

Engine system _____ Test No. _____

Isolator amplifier type _____ Serial No. _____

Accelerometer type _____ Serial No. _____

Calibration sensitivity _____ mv rms/g rms

_____
Signature

CONTROL CENTER

Vibration safety cutoff set No. _____

Critical g level _____

Input voltage: V_1 = _____ volts

Sensitivity setting _____

Attenuator setting _____

Delay time dial setting (seconds) $= \frac{T_d \text{ (seconds)}}{0.138 \times 10^{-3}} - (50)$

Storage time dial setting (seconds) $= \frac{T_s \text{ (seconds)}}{0.168 \times 10^{-3}} - \left(\text{delay time setting}\right) - 1.000$

Calibration indicated setting _____

_____
Signature

Figure 8-13. Suggested Calibration-Test Check Form

Step	Loc	Operation	Loc	Result
NOTE: The following abbreviations are used in this figure:				
	ACVM	AC voltmeter		
	AMP	Amplifier mounting panel		
	DCVM	DC voltmeter		
	IA	Isolator amplifier		
	Loc	Location		
	SG	Signal generator		
	VOM	Voltohmmeter		
	VSC	Vibration safety cutoff unit		
1		Obtain the following test equipment (figure 8-12): a. AC voltmeter b. DC voltmeter c. Signal generator d. Headphone e. Phone plug f. Voltohmmeter		
2	VSC	Disconnect connector P3 from J3 (figure 8-7 or 8-8) and perform the following:		
		a. Measure resistance between connector P3 and vibration safety cutoff unit chassis ground.	VOM	Greater than one megohm.
		b. Connect connector P3 to J3 and measure resistance between P3 and vibration safety cutoff unit chassis ground.	VOM	Less than one ohm
NOTE: Torque of receptacle J3 sleeve must be 40-50 inch-pounds to make sure contact is complete between receptacle and cutoff unit chassis.				
3	VSC	Move POWER switch to ON.		ARM light on
4	IA	Move toggle switch to ON.		Indicator light on

Figure 8-14. Preoperation and Calibration Test (Sheet 1 of 5)

Step	Loc	Operation	Loc	Result
5	IA	Rotate GAIN control to 1.0 and OUTPUT control to R. Allow instrument to warm up for 15 minutes.		No visible results
6	IA DCVM	Connect voltmeter (10 millivolts to 10 volts) to ZERO MONITOR, and adjust ZERO control until voltmeter indicates a null position.		
7	DCVM IA	Disconnect voltmeter.		
8	SG AMP ACVM	Disconnect INPUT and OUTPUT cable connectors. Connect signal generator and voltmeter to INPUT connector.		
9	SG	Adjust output voltage to 1 ±0.1 volt rms at 2,000 ±40 cps. Record voltage setting.		
10	ACVM AMP	Disconnect voltmeter from INPUT connector and connect it to OUTPUT connector. Adjust VARIABLE GAIN as required to obtain result.	ACVM	Voltage reading is within 2 percent of indication recorded in step 9.
NOTE: The variable gain control has a multiplication range of 2.5; therefore, it may require adjustment to reduce it to a multiplication of one.				
11	IA	Seal VARIABLE GAIN control with cap.		
12	ACVM AMP SG	Disconnect voltmeter and signal generator, and connect output cable to OUTPUT connector.		
13	IA	Record control settings.		
14	VSC	Move DISABLE-ARM switch to ARM.	VSC	ARM light on
15	VSC	If CUTOFF light is on, momentarily depress RESET switch.		
16	VSC	Unlock and rotate SENSITIVITY control to dial setting of 250.		No visible results
17	VSC	Unlock and rotate ACCELEROMETER ATTENUATOR control to dial setting of zero.	VSC	No visible results

Figure 8-14. Preoperation and Calibration Test (Sheet 2 of 5)

Step	Loc	Operation	Loc	Result
18		Using delay time dial setting and storage time dial setting equations (figure 8-13), compute and record delay time and storage time dial settings.		

NOTE: The storage time should be set for three to four times longer than the delay time, to make sure that a cutoff signal will be generated within a short time if the accelerometer signal contains predominantly positive or negative peaks or if one trigger circuit fails.

19	VSC	Unlock and rotate DELAY TIME and STORAGE TIME dials to settings computed in step 18. Lock controls. Record settings.		No visible results
20		Compute input voltage to be applied to amplifier input connector by computing the following equation: $V_1 = \frac{C_c + C_a}{C_s + C_a} S_s G_c$		

NOTE: Symbols used in equation are as follows:

V_1 Accelerometer on test signal at amplifier input

C_a Accelerometer capacitance

C_s Line capacitance plus amplifier input capacitance

C_c 1,650 picofarads (total capacitance shunting accelerometer during calibration)

S_s Sensitivity of accelerometer calibrated with C_c in shunt

G_c Critical g level at cutoff (nominal, 150 g)

21	SG	Adjust output voltage to value V_1 ±1 percent, at frequency of 2,000 ±40 cps, to isolator amplifier input connector. Record voltage.	VSC	CUTOFF light remains off.

Figure 8-14. Preoperation and Calibration Test (Sheet 3 of 5)

Step	Loc	Operation	Loc	Result
22		Fill out upper part of calibration-test check form (figure 8-11), retain carbon copy, and forward remaining set to control center for completion.		

NOTE: Test check form is used only to make sure that the settings established by calibration have not been changed.

23	VSC	Rotate ACCELEROMETER ATTENUATOR control clockwise until cutoff occurs. If cutoff is not obtained, rotate SENSITIVITY control clockwise until cutoff is obtained. If cutoff is still not obtained after complete rotation of controls, malfunction must be determined and corrected before proceeding with test; otherwise replace unit.	VSC	CUTOFF light on ARM light off.
24	VSC	Lock ACCELEROMETER ATTENUATOR and SENSITIVITY controls. Record control settings and value of V1 (calculated value of input signal at cutoff). (Refer to step 20.) Compare recorded settings with previous vibration safety cutoff unit dial setting values for respective unit. (Refer to value recorded in figure 8-14, steps 21 and 22.) The recorded control settings must be within ±5 percent of the respective readings previously obtained, provided the critical g level for both V1 values is the same. If g level has changed, perform procedure for verification of accelerometer and sensitivity control dial settings (paragraph 8-28).	VSC	No visible results
25	VSC	Apply 24-32 vdc to pins J1-J (positive) and J1-K (negative).	VSC	ARM light on CUTOFF light off
26	VSC	Remove 24-32 vdc from pins J1-J and J1-K.	VSC	CUTOFF light on ARM light off
27	VSC	Apply 24-32 vdc to pins J1-F (positive) and J1-H (negative)	VSC	DISABLE light on CUTOFF light off
28	VSC	Remove 24-32 vdc from pins J1-F and J1-H.	VSC	CUTOFF light on DISABLE light off
29	VSC	Momentarily move DISABLE-ARM switch to DISABLE.	VSC	CUTOFF light off momentarily DISABLE light on momentarily

Figure 8-14. Preoperation and Calibration Test (Sheet 4 of 5)

Step	Loc	Operation	Loc	Result
30	VSC IA	Disconnect test equipment from iso ator amplifier and connect accelerometer cable to isolator amplifier INPUT connector.		
31	VSC	Connect a phone plug and a set of headphones to MONITOR jack.		
32	VSC	Momentarily depress RESET switch.	VSC	ARM light on CUTOFF light off
33	VSC	Move POWER switch to OFF.	VSC	ARM light off
34	IA	Move toggle switch to OFF.	IA	Indicator light off
35	VSC	Mark ACCELEROMETER ATTEN-UATOR and SENSITIVITY dial setting on a gummed label and place on front panel for quick reference to settings.		

Figure 8-14. Preoperation and Calibration Test (Sheet 5 of 5)

8-25. PREOPERATION TAP TEST. A tap test must be performed to make sure that continuity exists between the accelerometer and the vibration safety cutoff unit, as determined by an audible signal received on the headphone. (See figure 8-15 for preoperation tap test.)

Step	Loc	Operation	Loc	Result
1	VSC	Move power switch to ON.	VSC	ARM light on
2	IA	Move toggle switch to ON.	IA	Indicator light on
3	VSC	Insert headphone plug into MONITOR.	VSC	No result
4	VSC	Tap thrust chamber dome gently, using a brass hammer. Adjust HEADPHONES ATTENUATOR control to obtain audible signal.	VSC	Audible signal
5	VSC	Move POWER switch to OFF.		ARM light off
6	IA	Move toggle switch to OFF.		Indicator light off
7	VSC	Remove headphone plug from MONITOR.	VSC	No result

Figure 8-15. Preoperation Tap Test--Thrust Chamber Dome

8-26. FUNCTION-TESTING VIBRATION SAFETY CUTOFF UNIT. Function-testing the vibration safety cutoff unit is required at specified intervals, any time a unit is repaired or modified, or whenever a malfunction is suspected. Function-testing procedures are listed in figure 8-16. The procedures must be performed in the order in which they appear. If results other than those specified are obtained, the test must be terminated and the malfunction isolated and repaired. As an aid in function-testing or isolating malfunctions, see figure 8-17 for an electrical schematic and figure 8-18 for an electrical wiring diagram.

Step	Loc	Operation	Loc	Result
NOTE: The following abbreviations are used in this figure:				
	ACVM	AC voltmeter		
	DCVM	DC voltmeter		
	DC	Digital counter		
	Loc	Location		
	OSC	Oscilloscope		
	SG	Signal generator		
	TS	Vibration safety cutoff test set		
	VSC	Vibration safety cutoff unit		
1		Obtain test equipment listed in figure 8-12, except headphones and voltohmmeter.		
2	VSC	Move DISABLE-ARM switch to ARM.		No visible results
3	VSC	Make sure that POWER switch is in OFF position.		No visible results
4	VSC	Rotate the following control fully clockwise: a. ACCELEROMETER ATTENUATOR b. DELAY TIME c. HEADPHONES ATTENUATOR		No visible results
5	VSC TS	Rotate the following controls fully counterclockwise: a. SENSITIVITY b. STORAGE TIME c. PULSE WIDTH		No visible results
6	TS VSC ACVM	Connect test equipment and cables as shown in figure 8-19, but do not connect signal generator. Observe polarity when connecting test set to 28 vdc power supply.		

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 1 of 10)

Step	Loc	Operation	Loc	Result
7	TS	Make sure that all switches are in OFF position.		No visible results
8	TS	Depress 2 AMPS circuit breaker.		No visible results
9	TS	Move POWER switch to ON	TS	28 VDC POWER light on CUTOFF NO. 1 OFF light on CUTOFF NO. 2 OFF light on CUTOFF NO. 3 OFF light on
10	TS	Momentarily depress LAMP TEST switch	TS	CUTOFF NO. 1 ON light on momentarily CUTOFF NO. 2 ON light on momentarily CUTOFF NO. 3 ON light on momentarily
11	VSC	Move POWER switch to ON.		ARM light on
12	VSC	Short-circuit connector J3.		No visible results
NOTE: Results obtained in steps 13 through 92 must be recorded as specified on form shown in figure 8-19.				
13	VSC	Measure dc voltage between jacks TP14 and TP18 (negative). Record. Disconnect voltmeter.	DCVM	15.2 to 16.8 vdc
14	VSC	Measure ac voltage between jacks TP4 and TP18. Record. Disconnect voltmeter.	ACVM	Noise level less than 0.020 vac rms
15	VSC	Remove short circuit from connector J3.		No visible results
16	TE VSC	Connect ac voltmeter to jacks TP7 and TP18. Select scale for 15-volt indicatio' .		
17	SG VSC	Connect signal generator to receptacle J3. Observe polarity. Refer to figure 8-17.		
18	SG	Set frequency dial to 2,000 ±50 cps and output voltage control to zero.		No visible results

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 2 of 10)

Step	Loc	Operation	Loc	Result
19	SG	Slowly increase output voltage until ac voltmeter suddenly moves upscale.	VSC	CUTOFF light on
				ARM light off
			TS	CUTOFF NO. 1 ON light on
				CUTOFF NO. 1 OFF light off
				CUTOFF NO. 2 ON light on
				CUTOFF NO. 2 OFF light off
				CUTOFF NO. 3 ON light on
				CUTOFF NO. 3 OFF light off
20	SG ACVM	Slowly reduce output voltage until ac voltmeter indication suddenly decreases to zero and remains at zero.		
21	SG ACVM	Measure ac voltage at output of signal generator. Record trigger level input.	ACVM	0.13 to 0.37 vac
22	VSC	Measure ac voltage between jacks TP4 and TP18. Record trigger level input. Disconnect voltmeter.	TS	0.9 to 1.1 vac
23	SG	Reduce output voltage to zero.		No visible results
24	VSC	Momentarily depress RESET button.	VSC	ARM light on
				CUTOFF light off
			TS	CUTOFF NO. 1 OFF light on
				CUTOFF NO. 1 ON light off
				CUTOFF NO. 2 OFF light on
				CUTOFF NO. 2 ON light off
				CUTOFF NO. 3 OFF light on
				CUTOFF NO. 3 ON light off
25	VSC	Repeat steps 16 through 22 substituting jacks TP8 for TP7. Do not change signal generator setting after completion of step 22. Record.		
26	VSC	Measure and record components gain ac voltage between the following jacks:		
		a. TP1 and TP18	ACVM	0.95 times voltage recorded in step 21, ±2%
		b. TP2 and TP18	ACVM	0.13 vac minimum
		c. TP3 and TP18	ACVM	0.004 vac maximum

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 3 of 10)

Step	Loc	Operation	Loc	Result
27	SG	Reduce output voltage to zero.		
28	VSC ACVM	Unlock and rotate SENSITIVITY control fully clockwise; then connect ac voltmeter to jacks TP4 and TP18.		No visible results
29	SG	Increase output voltage until ac voltmeter indicates 0.95 to 1.05 vac.		
NOTE: If signal generator cannot be adjusted low enough to accomplish this, a voltage-dividing potentiometer of approximately 5,000 ohms may be connected across the signal generator output.				
30	VSC	Measure voltage between jacks TP2 and TP18. Record components gain. Disconnect voltmeter.	ACVM	0.08 vac maximum
31	TS VSC	Move DEACTIVATE RELAY switch to (+) positive.	VSC	DISABLE light on CUTOFF light off
32	VSC	Measure voltage between jacks TP4 and TP18.	ACVM	0.1 vac maximum
33	TS	Move DEACTIVATE RELAY switch to OFF.	VSC	CUTOFF light on DISABLE light off
34	VSC	Measure voltage between jacks TP4 and TP18. Record.	ACVM	0.95 to 1.05 vac
35	TS	Move DEACTIVATE RELAY switch to (-) negative.	VSC	DISABLE light on CUTOFF light on
36	TS	Measure voltage between jacks TP4 and TP18.	ACVM	Same result as step 34
37	TS	Move DEACTIVATE RELAY switch to OFF. Disconnect voltmeter.	VSC	DISABLE light off
38	VSC TE	Connect voltmeter between jacks TP1 and TP18.		
39	SG	Adjust output voltage until voltmeter indicates 0.02 ±0.002 vac rms.		
40	VSC	Measure voltage between MONITOR jack and jack TP18.	ACVM	0.1 vac rms minimum
41	VSC	Disconnect signal generator from receptacle J3.		

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 4 of 10)

Step	Loc	Operation	Loc	Result
42	VSC	Measure voltage between MONITOR mack and jack TP18.	ACVM	0.070 vac rms maximum
43	VSC SG TE	Reconnect signal generator to receptacle J3.		
44	VSC	Rotate SENSITIVITY control fully counterclockwise.		No visible results
45	VSC	Connect ac voltmeter between jacks TP2 and TP18.		
46	SG ACVM	Adjust frequency to 2,000 ±20 cps and voltage output until voltmeter indicates 0.5 ±0.01 volt.		
47	VSC ACVM	Momentarily disconnect voltmeter lead from jack TP2 and measure signal generator output voltage. Record.		
48	SG	Adjust signal generator frequency to 480 ±1 percent. Use digital counter to verify frequency settings.	DC	475-485 cps
49	VSC SG	Momentarily disconnect voltmeter lead from jack TP2 and measure signal generator output voltage.	ACVM	Within 3 percent of voltage recorded in step 47
NOTE: It may be necessary to adjust signal generator output voltage to obtain the result in step 49.				
50	VSC	Measure voltage between jacks TP2 and TP18.	ACVM	0.025 vac maximum
51		Repeat steps 48 through 50 using the following signal generator frequencies.		
		a. 700 ±7 cps		0.04 volt maximum
		b. 930 ±30 cps		0.35 volt maximum
		c. 1,150 ±11 cps		0.035 to 0.65 volt rms
		d. 4,800 48 cps		0.035 to 0.65 volt rms
		e. 6,000 (+160, -200 cps)		0.35 volt
		f. 8,000 ±80 cps		0.04 volt maximum
		g. 12,000 ±120 cps		0.025 volt maximum
NOTE: Frequencies at 930 and 6,000 cps may be varied within the given tolerance to obtain the results.				
52	VSC	Rotate HEADPHONES ATTENUATOR control fully clockwise.		No visible results

Figure 8-16. Function Testing Vibration Safety Cutoff Unit (Sheet 5 of 10)

Step	Loc	Operation	Loc	Result
53	ACVM VSC OSC	Connect voltmeter and input of oscilloscope in parallel between jacks TP1 and TP18.		
54	SG	Adjust frequency to 500 ±10 cps and output voltage to maximum obtainable without causing distortion or wave clipping.	ACVM	2.45 vac minimum
NOTE: Clipping is defined as a deviation of greater than 10 percent from sine wave. Estimate from oscilloscope trace.				
55	OSC	Set oscilloscope as follows: a. Set total sweep time: 2 milliseconds. b. Vertical sensitivity: to observe 16 volts.		
56	VSC ACVM	Connect voltmeter between jacks TP4 and TP18.		
57	SG ACVM	Adjust frequency to 1 000 ±100 cps and output voltage until voltmeter indicates 1.5 ±0.3.		
58	OSC	Remove signal probe from jack TP1 and connect probe to TP7. Adjust trigger to synchronize oscilloscope.		
59		(Deleted)		
60	SG	Measure pulse width, spacing, and amplitude as follows: a. Slowly increase frequency. b. Observe that as frequency increases, leading edge of each negative pulse approaches trailing edge of preceding pulse. c. Note that at some critical frequency, pulses will suddenly widen. d. Increase frequency to a point as near critical frequency as possible and measure pulse width, spacing, and amplitude. (See figure 8-20.)	OSC	Pulse measurement must be as follows: Width: 400 microseconds (minimum) Spacing: 200 microseconds (maximum) Amplitude: 13 volts (minimum)
61		Repeat steps 55 through 60 substituting jack TP8 for TP7.		

Figure 8-16 Function-Testing Vibration Safety Cutoff Unit (Sheet 9 of 10)

Step	Loc	Operation	Loc	Result
62	OSC	Disconnect oscilloscope.		
63	SG ACVM	Adjust signal generator frequency to 1,000 ±50 cps and increase output voltage to 2.0 ±0.4 vac.		
64	VSC DCVM	Connect voltmeter between jacks TP12 and TP18.		
65	SG ACVM	Adjust output voltage to maintain 2.0 ±0.4 volts at jack TP4, while increasing frequency to 6,000 ±100 cps.	DCVM	10 vdc minimum
66	SG VSC	Disconnect signal generator from receptacle J3 and ac voltmeter from jack TP4. Measure dc voltage between jacks TP12 and TP18.	DCVM	0.2 vdc maximum
67	VSC	Short-circuit jacks TP10 to TP18 and measure voltage between jacks TP12 and TP18	DCVM	0.4 vdc maximum
NOTE: A shorting lead equipped with an alligator clip attached to dc voltmeter probe in jack TP18 is suggested.				
68	VSC	Remove shorting lead from jack TP10 and short-circuit jack TP11 to jack TP18. Measure voltage between jacks TP12 and TP18.	DCVM	0.4 vdc maximum
69	VSC	Disconnect shorting lead and dc voltmeter.		
70	TS VSC	Connect a test lead between TIMER STORAGE TEST jack and jack TP9.		
71	OSC	Connect test probe in series with 5-megohm resistor to jack TP13 and external trigger jack to jack TP12. Use oscilloscope channel A.		
NOTE: A high-impedance oscilloscope probe of 5 megohms or more may be used instead of the probe resistor combination.				
72	OSC	Set oscilloscope controls as follows: a. Vertical amplifier for dc inputs b. Sweep time control to 200 milliseconds total sweep c. External triggering mode control to positive dc		

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 7 of 10)

Step	Loc	Operation	Loc	Result
73	VSC	Rotate STORAGE TIME control fully counterclockwise and DELAY TIME control fully clockwise.		No visible results
74	TS OSC	Adjust PULSE WIDTH control and oscilloscope synchronizing controls to obtain a delay time wave pattern shown in figure 8-21. Record time delay (T_d).	OSC	120-200 milliseconds
75	OSC	Set sweep time to 10.0 milliseconds total sweep.		
76	VSC	Rotate DELAY TIME control fully counterclockwise. Record delay time (T_d).	OSC	10 milliseconds maximum
77	OSC	Set total sweep time to 500 milliseconds.		
78	VSC	Rotate DELAY TIME control fully clockwise.		No visible results
79	TS OSC	Adjust PULSE WIDTH control and oscilloscope positioning controls to obtain storage time wave pattern shown in figure 8-21.		
80	VSC	Rotate STORAGE TIME control fully counterclockwise.		No visible results
81	OSC	Position storage time wave pattern as shown in figure 8-21. Note position at 1/3 V_p. Record storage time (T_s).	OSC	285-385 milliseconds
82	VSC	Rotate STORAGE TIME control fully clockwise.		No visible results
83	OSC	Set total sweep for approximately 600 milliseconds.		
84	OSC	Position storage time wave form as shown in figure 8-21. Measure and record maximum storage time (T_s).	OSC	425-575 milliseconds
85	VSC	Rotate DELAY TIME and STORAGE TIME controls to dial setting 500.		No visible results
86	TS	Adjust PULSE WIDTH control to obtain storage time wave pattern shown in figure 8-21. Record storage time (T_s).	OSC	285-385 milliseconds

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 8 of 10)

Step	Loc	Operation	Loc	Result
87	VSC	Rotate DELAY TIME control to 100.		No visible results
88	VSC TS	Connect test lead between jack TP12 and TIMER RELAY TEST jack		
89	TS	Move RESET RELAY switch to ON.	VSC	CUTOFF light flashes
				ARM light flashes
			TS	CUTOFF NO. 1 ON light flashes
				CUTOFF NO. 1 OFF light flashes
				CUTOFF NO. 2 ON light flashes
				CUTOFF NO. 2 OFF light flashes
				CUTOFF NO. 3 ON light flashes
				CUTOFF NO. 3 OFF light flashes
90	TS OSC	Adjust PULSE WIDTH control until delay time wave shown in figure 8-21 is obtained on channel A.	VSC	CUTOFF light flashes
				ARM light flashes
			TS	CUTOFF NO. 1 ON light flashes
				CUTOFF NO. 1 OFF light flashes
				CUTOFF NO. 2 ON light flashes
				CUTOFF NO. 2 OFF light flashes
				CUTOFF NO. 3 ON light flashes
				CUTOFF NO. 3 OFF light flashes
NOTE: Perform steps 91 and 92 only if relay K3 was replaced during maintenance.				
91	TS OSC	Connect oscilloscope channel B test probe to PULSE WIDTH TEST jack.		
92	OSC	Adjust oscilloscope controls as follows: a. Set total sweep time for 50 milliseconds.	OSC	T_c less than 5 milliseconds

Figure 8-16 Function-Testing Vibration Safety Cutoff Unit (Sheet 9 of 10)

Step	Loc	Operation	Loc	Result
92 (cont)		b. Mode select switch to CHOP. c. Amplitude controls until cutoff time wave form shown in figure 8-21 is obtained. Record cutoff time (T_c).		
93	VSC	Move POWER switch to OFF.	VSC	CUTOFF light off ARM light off
			TS	CUTOFF NO. 1 OFF light on CUTOFF NO. 1 ON light off CUTOFF NO. 2 OFF light on CUTOFF NO. 2 ON light off CUTOFF NO. 3 OFF light on CUTOFF NO. 3 ON light off
NOTE: Perform step 94, substep c, only if relay K3 was replaced during maintenance.				
94	OSC TS VSC	Disconnect the following test leads: a. Jack TP12 and TIMER RELAY TEST jack b. Jack TP9 and TIMER STORAGE TEST c PULSE WIDTH TEST jack and oscilloscope		
95	TS	Move RESET RELAY switch OFF and rotate PULSE WIDTH control fully counterclockwise.		No visible results
96	VSC	Move POWER switch ON.	VSC	ARM light on
			TS	No visible results
97	VSC	Move POWER switch OFF.		ARM light off
98	TS	Move POWER switch OFF.	TS	CUTOFF NO. 1 OFF light off CUTOFF NO. 2 OFF light off CUTOFF NO. 3 OFF light off
99		Disconnect and secure test equipment.		28 VDC POWER light off

Figure 8-16. Function-Testing Vibration Safety Cutoff Unit (Sheet 10 of 10)

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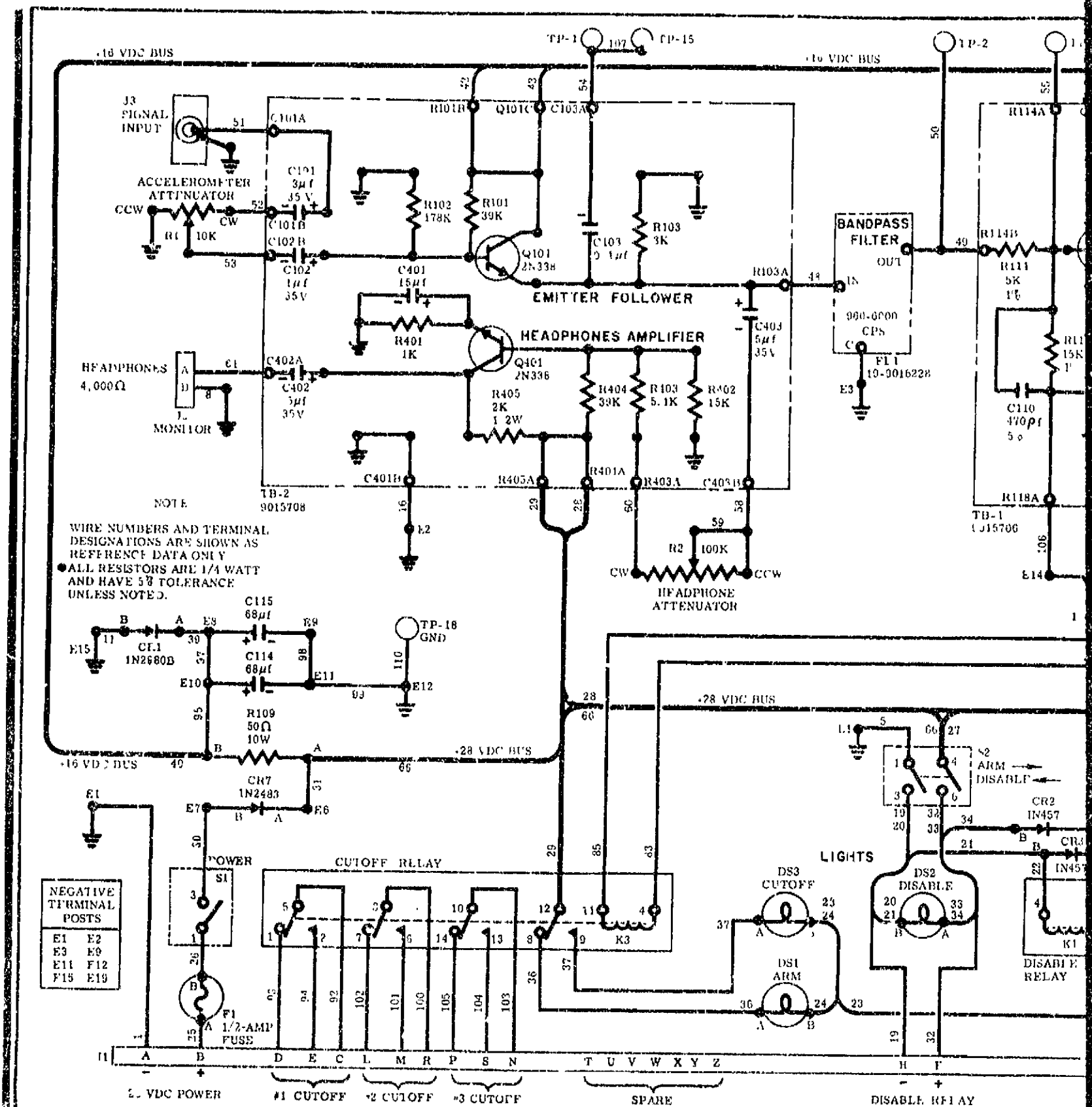
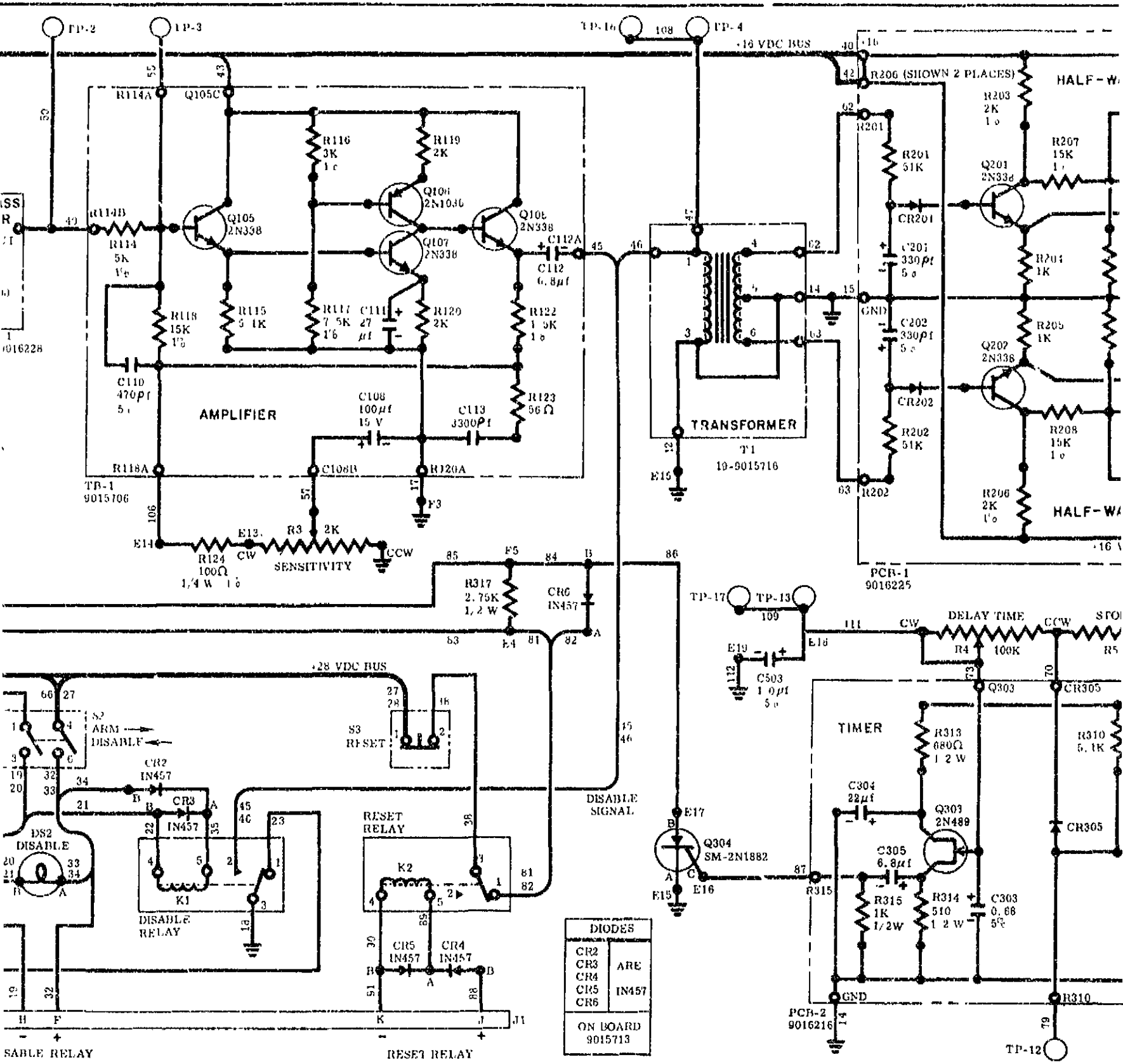
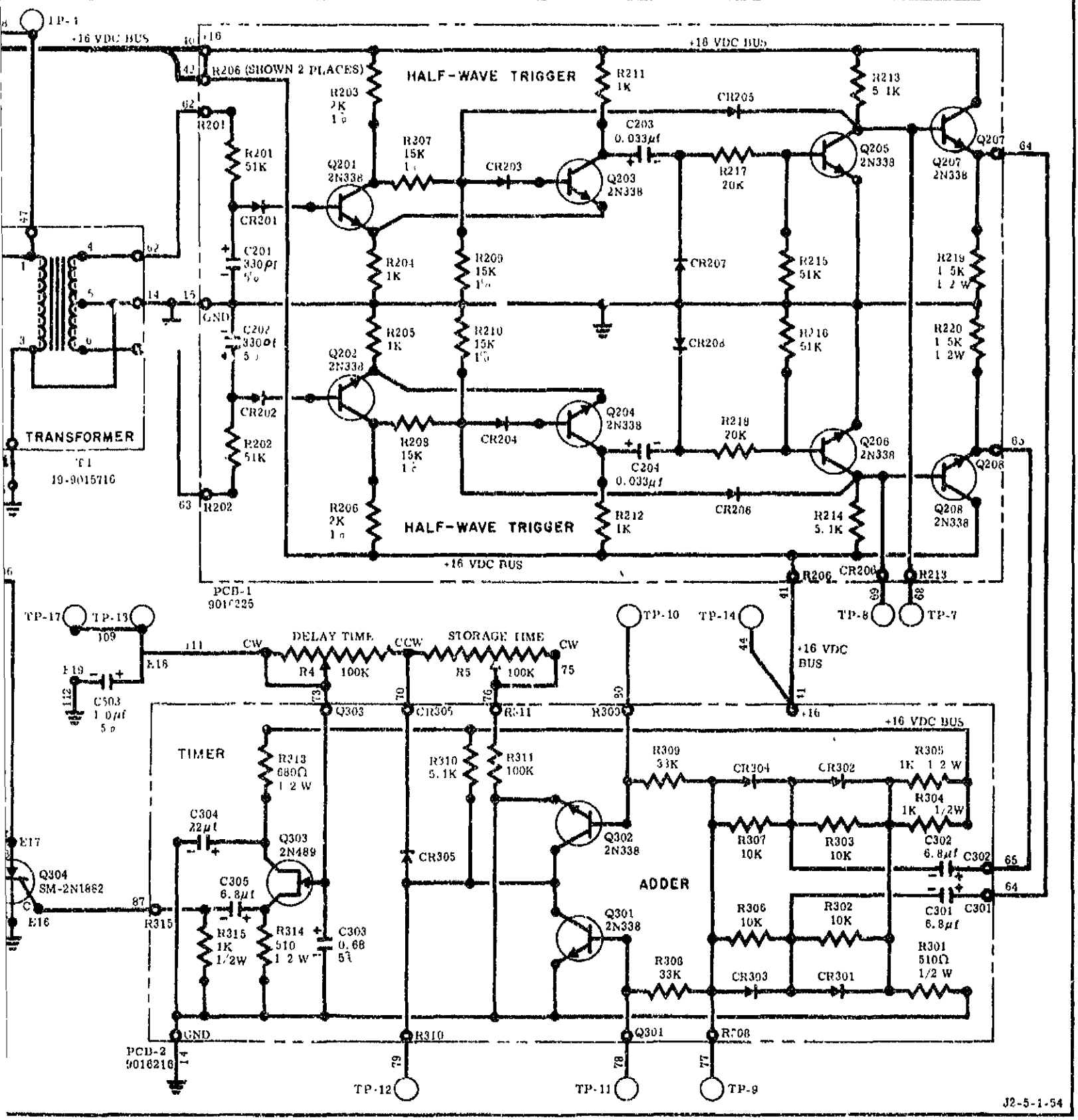
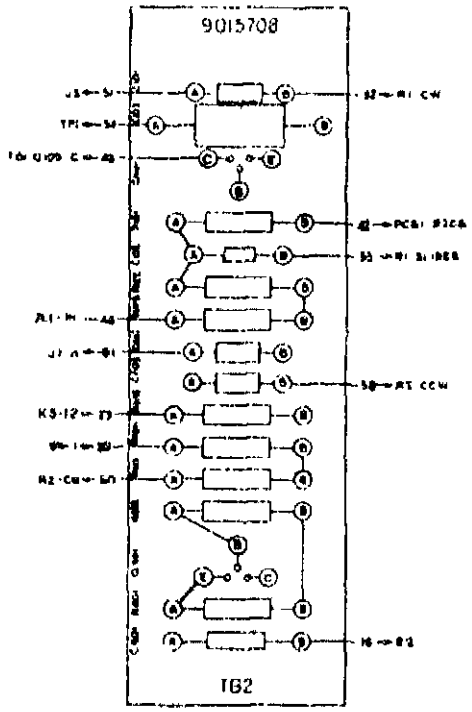
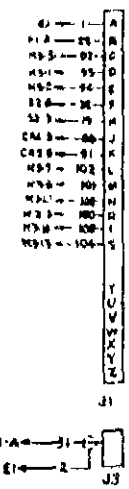


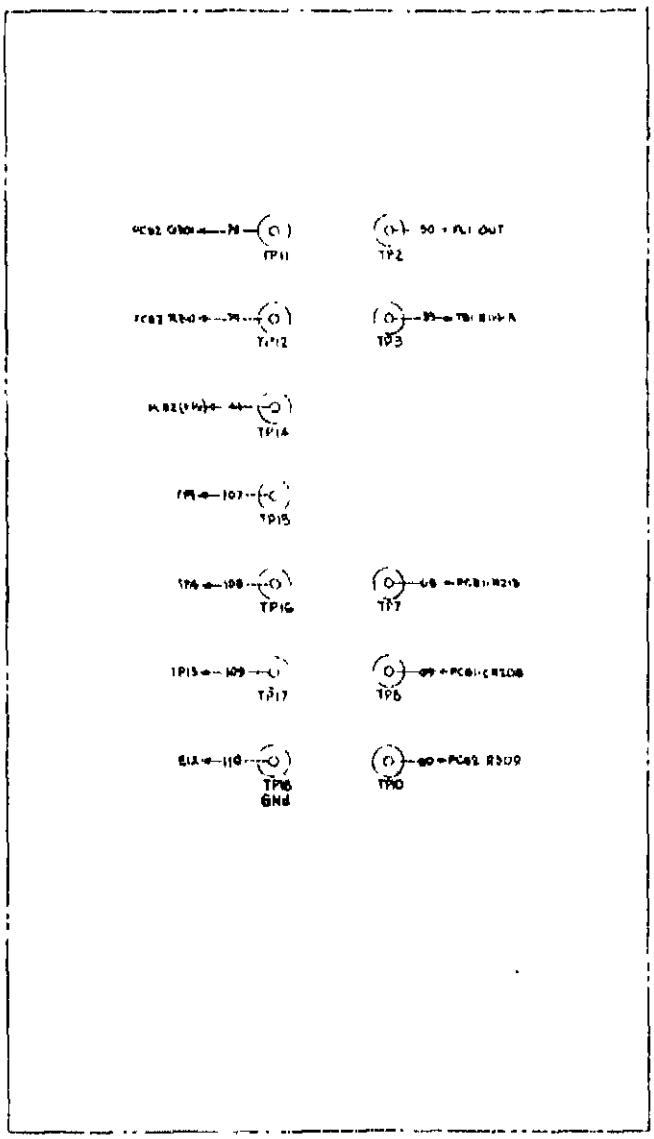
Figure 8-17. Vibration Safety Cutoff Unit Electrical Schematic

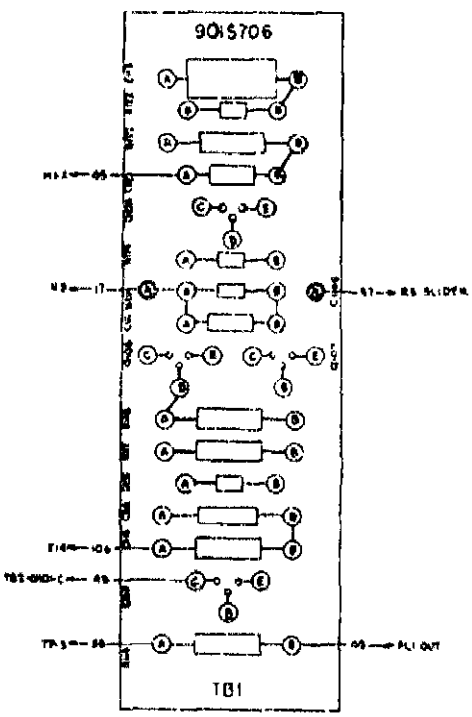

TP-2
TP-3
TP-16
108
TP-4
+16 VDC BUS
R114A
Q105C
R114B
R114
5K
1%
Q105
2N338
R116
3K
1%
R119
2K
Q106
2N1036
Q107
2N338
Q108
2N338
C112A
C112
6.8μf
R118
15K
1%
R115
5.1K
R117
7.5K
1%
C111
27
μf
R120
2K
R122
1.5K
1%
C110
470pf
5%
AMPLIFIER
C108
100μf
15 V
C113
3300pf
R123
56Ω
R118A
C108B
R120A
TB-1
9015706
F3
E13
R3
2K
E14
R124
100Ω
1/4 W 1%
CW
CCW
SENSITIVITY
TRANSFORMER
T1
19-9015716
E15
R206 (SHOWN 2 PLACES)
R201
R201
51K
CR201
C201
330pf
5%
R202
51K
CR202
C202
330pf
5%
R202
GND
R203
2K
1%
R207
15K
1%
Q201
2N338
R204
1K
R205
1K
Q202
2N338
R208
15K
1%
R206
2K
1%
HALF-WA
PCB-1
9016225
R317
2.75K
1/2 W
CR6
IN457
TP-17
TP-13
109
E19
C503
1.0μf
5%
E18
CW
DELAY TIME
CCW
R4
100K
R5
+28 VDC BUS
S2
ARM
DISABLE
S3
RESET
CR2
IN457
CR3
IN457
DS2
DISABLE
DISABLE
RELAY
K1
RESET
RELAY
K2
DISABLE
SIGNAL
CR5
IN457
CR4
IN457
E17
Q304
SM-2N1882
E16
TIMER
Q303
CR305
R313
680Ω
1 2 W
C304
22μf
Q303
2N489
C305
6.8μf
R315
1K
1/2W
R314
510
1 2 W
C303
0.68
5%
R315
R310
5.1K
GND
PCB-2
9016216
R310
TP-12
DIODES
CR2
CR3
CR4
CR5
CR6
ARE
IN457
ON BOARD
9015713
SABLE RELAY
RESET RELAY


TP-1
+16 VDC BUS
+16
R206 (SHOWN 2 PLACES)
HALF-WAVE TRIGGER
R203 2K 1%
R211 1K
R213 5.1K
CR205
C203 0.033μf
R307 15K 1%
R201 51K
Q201 2N338
CR203
Q203 2N338
R217 20K
Q205 2N338
Q207 2N338
CR201
C201 330pf 5%
R204 1K
R209 15K 1%
CR207
R215 51K
R219 1.5K 1.2W
GND
C202 330pf 5%
R205 1K
R210 15K 1%
CR206
R216 51K
R220 1.5K 1.2W
Q202 2N338
CR202
R208 15K 1%
CR204
Q204 2N338
R218 20K
Q206 2N338
Q208 2N338
C204 0.033μf
TRANSFORMER
T1
19-9015716
R202 51K
R206 2K 1%
HALF-WAVE TRIGGER
R212 1K
R214 5.1K
+16 VDC BUS
PCB-1
9016225
R206
CR206
R213
TP-8
TP-7
TP-17
TP-13
TP-10
TP-14
+16 VDC BUS
DELAY TIME
STORAGE TIME
CW
CCW
R4 100K
R5 100K
C503 1.0μf 5%
Q303
CR305
R311
R309
+16
TIMER
R313 680Ω 1.2W
R310 5.1K
R311 100K
+16 VDC BUS
R309 33K
CR304
CR302
R305 1K 1.2W
R304 1K 1/2W
C304 .22μf
Q303 2N489
Q302 2N338
R307 10K
R303 10K
C302 6.8μf
C302
CR305
ADDER
C305 6.8μf
Q301 2N338
R306 10K
R302 10K
C301 6.8μf
C301
Q304 SM-2N1862
R315
R315 1K 1/2W
R314 510 1.2W
C303 0.68 5%
R308 33K
CR303
CR301
R301 510Ω 1/2W
GND
R310
Q301
R308
PCB-2
9016216
TP-12
TP-11
TP-9
J2-5-1-54


9015708
TB2


J1
J3




9015706
TB1

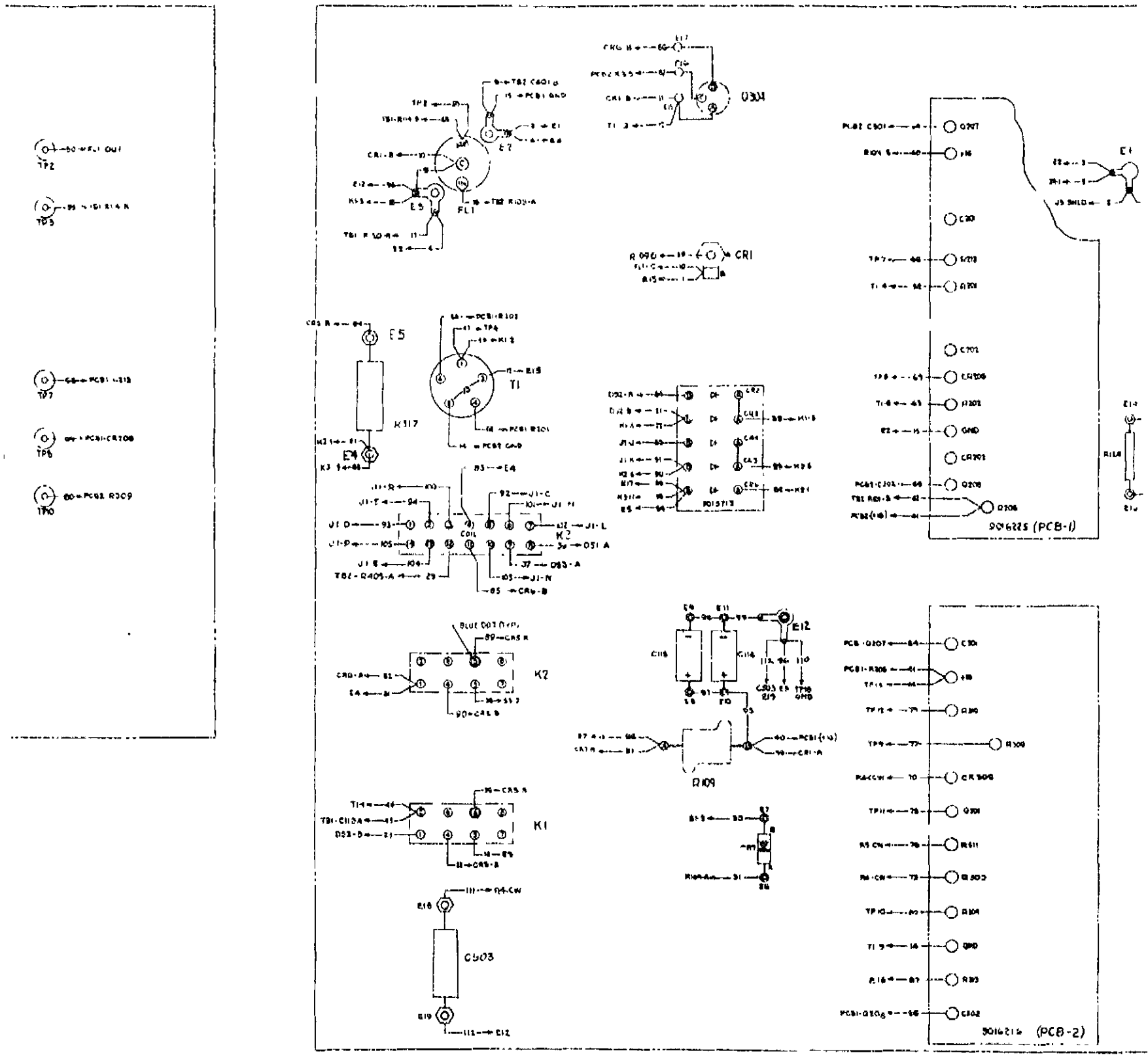


Figure 8-18.

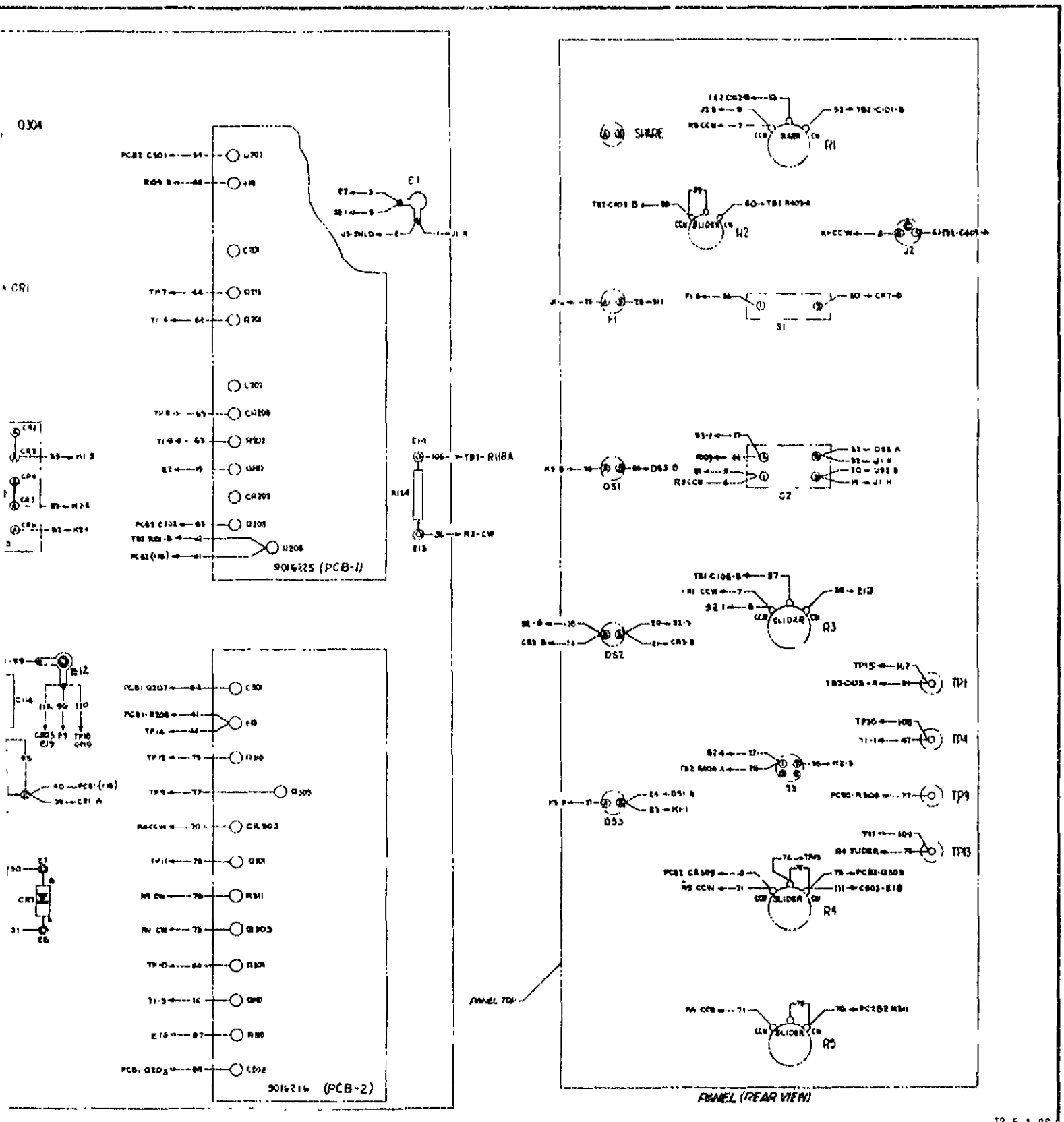
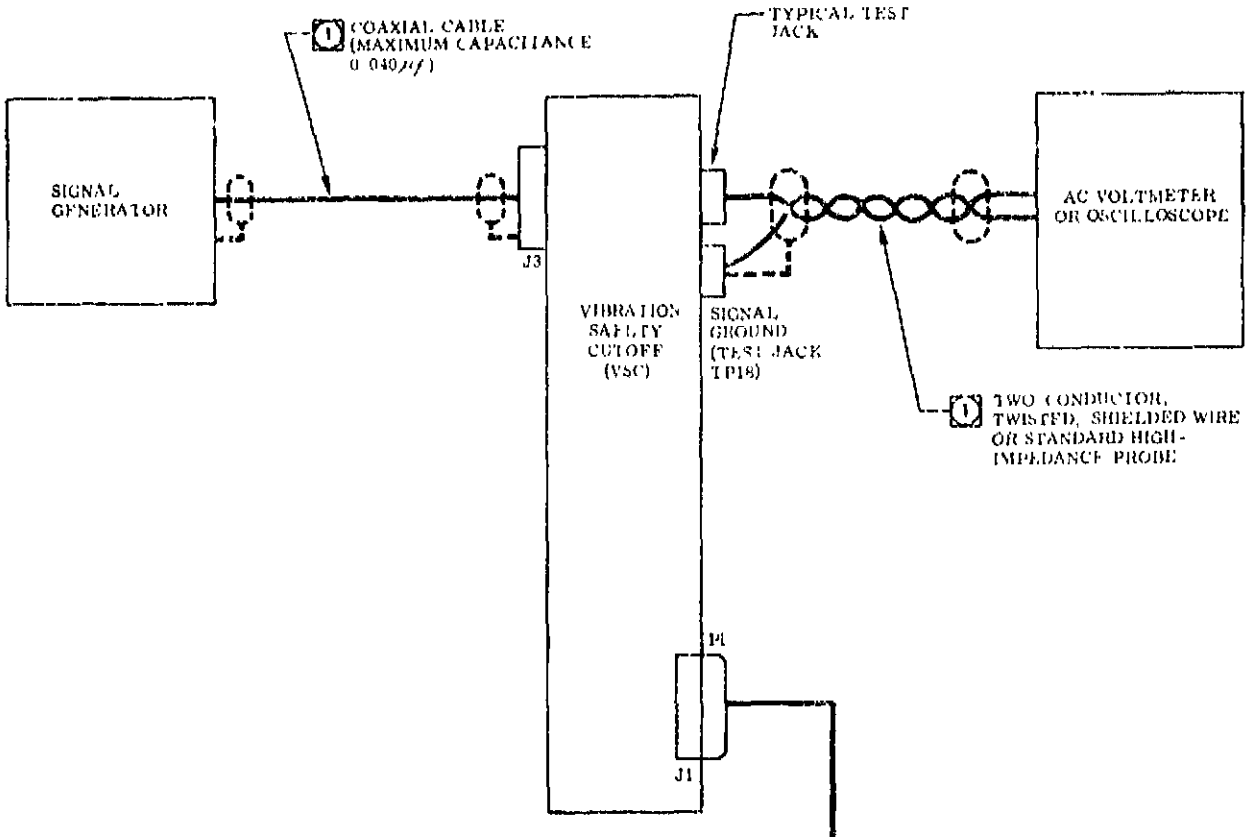


Figure 8-18. Vibration Safety Cutoff Unit Electrical Wiring Diagram



DATE
PAGE.

TEST DATA RECORD SHEET

UNIT: VIBRATION SAFETY CUTOFF SET G1038

TYPE OF TEST	SPECIFIED MIN.	SPECIFIED MAX	MEASURED VALUE	CHECK OK	CHECK REJ	DETAILS
POWER SUPPLY	15.2 VDC	16.0 VDC				
NOISE LEVEL		0.020 VAC RMS				
TRIGGER INPUT LEVEL (TP7)	0.13 VAC RMS	0.37 VAC RMS				
TRIGGER INPUT LEVEL (TP4)	0.9 VAC RMS	1.1 VAC RMS				
TRIGGER INPUT LEVEL (TP8)	0.13 VAC RMS	0.37 VAC RMS				
TRIGGER INPUT LEVEL (TP4)	0.9 VAC RMS	1.1 VAC RMS				
COMPONENT GAINS (TP1)						
COMPONENT GAINS (TP2)	0.13 VAC					
COMPONENT GAINS (TP3)		0.004 VAC				
COMPONENT GAINS (TP2, WITH 1.0 VAC AT TP4)		0.08 VAC				

J2-5-1-8

Figure 8-19. Vibration Safety Cutoff Unit Test Setup and Data Record Sheet

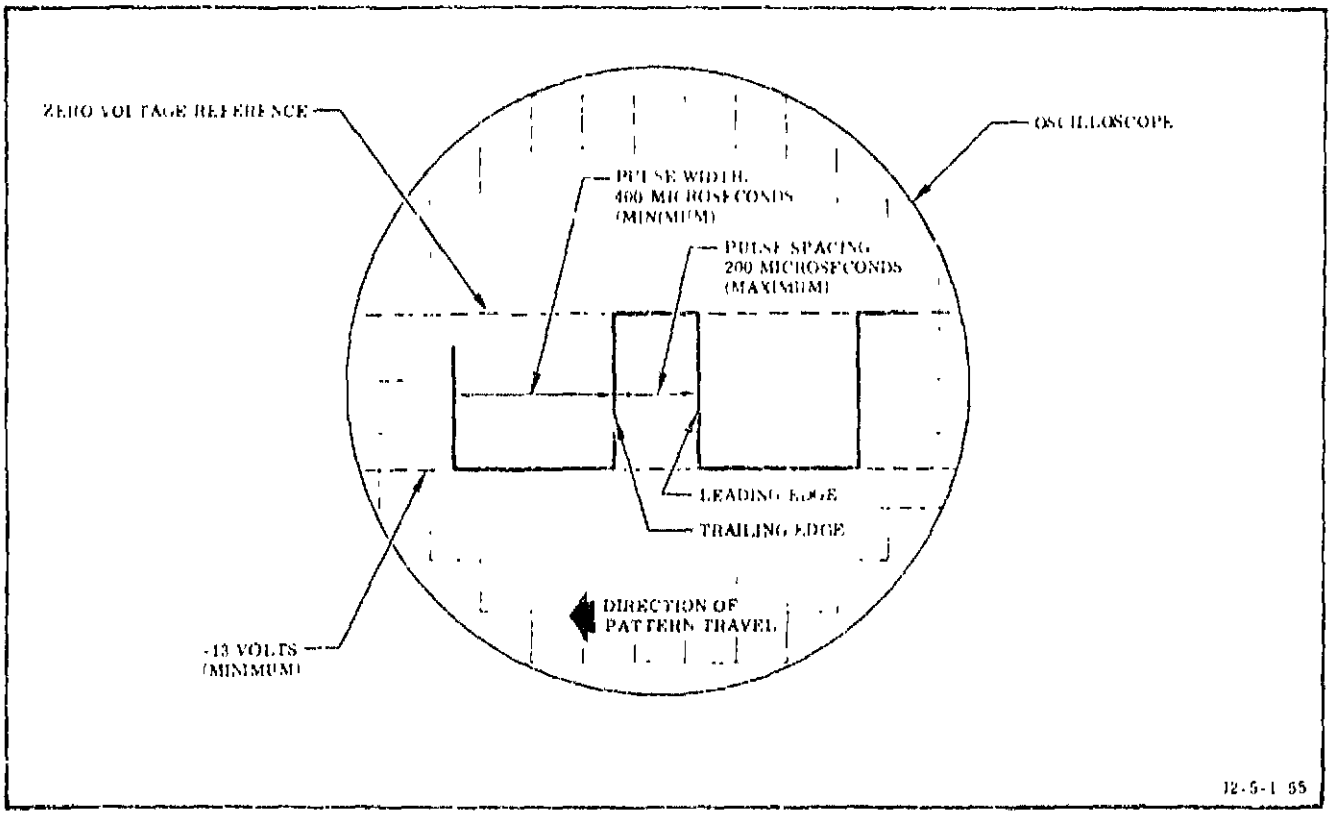
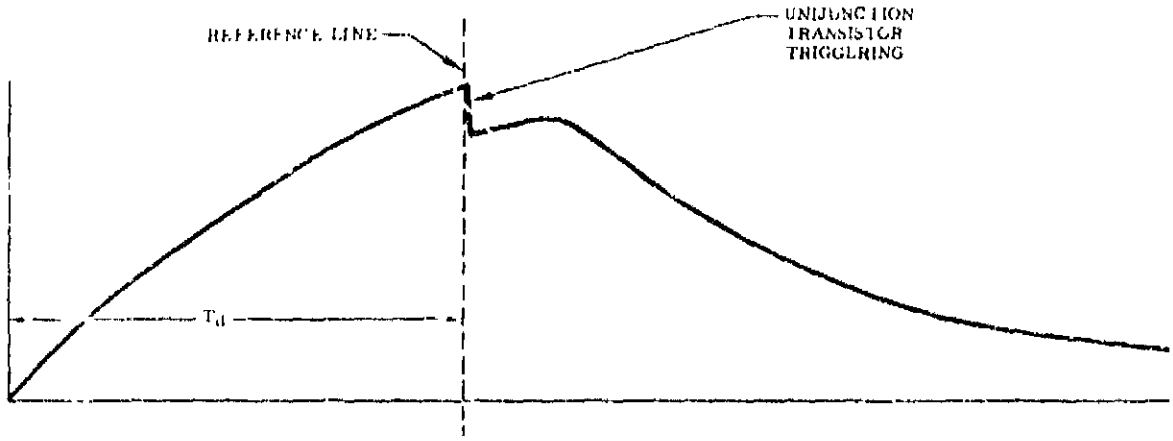
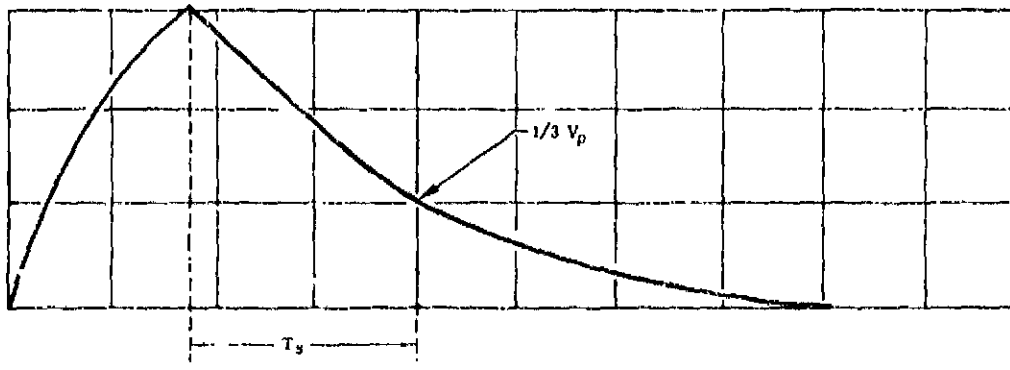


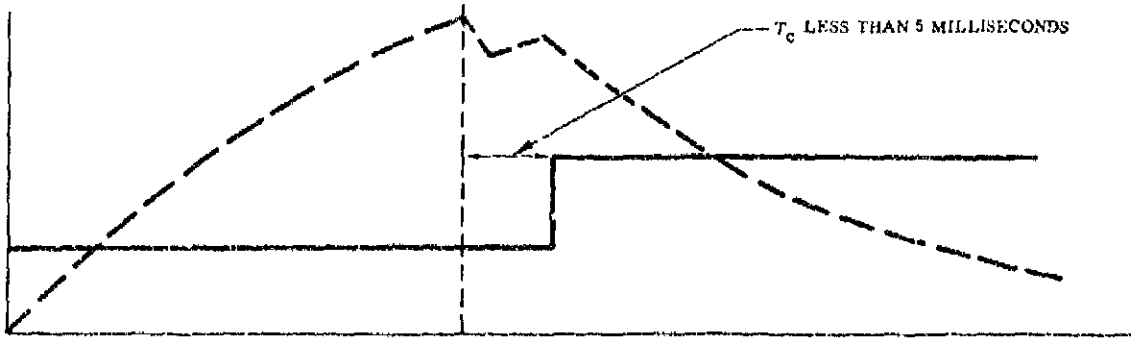
Figure 8-20. Measuring Vibration Safety Cutoff Unit Trigger Pulse Width



DELAY TIME



STORAGE TIME AT TP13



CUTOFF TIME

J2-5-1-14

Figure 8-21. Vibration Safety Cutoff Unit Test Patterns

8-27. TESTING VIBRATION SAFETY CUTOFF UNIT DC VOLTAGE LEVEL. A dc voltage level test is performed to detect improper operation of the vibration safety cutoff unit components and assist in malfunction isolation.

a. Move POWER switch to ON.

b. Depress RESET switch.

c. With no input signal applied to connector J3, measure voltage between ground (TP18) and test point junctions listed in figure 8-22. The dc voltage indications obtained must be within 5 percent of those listed.

Test Point Junctions	DC Volt Levels
R101, R102	11.5
R102, C103	10.9
R114, R118	5.3
R115, Q105	4.7
R116, R117	11.4
R120, Q107	3.9
Q106, Q107	10.3
R119, Q106	12.1
R122, C112	9.6
R118, R122	5.5
R109, CR1	16.0
R203, R207	15.0
R207, R209	7.2
R204, Q201	6.0
R211, C203	10.0
R213, Q205	15.5
R219, C301	14 9
C301, R302	6.5
R301, R304	8
R306, R308	5
R310, CR305	0.2
R402, R404	6.8
R401, Q401	6.1
R405, C402	15.8

Figure 8-22. Vibration Safety Cutoff Unit DC Voltage Levels

8-28. VERIFICATION OF ACCELEROMETER ATTENUATOR AND SENSITIVITY CONTROL DIAL SETTINGS. The chart (figure 8-23) establishes the values of the input voltage required to obtain cutoff versus the SENSITIVITY and ACCELEROMETER ATTENUATOR dial settings. The settings obtained during system checkout will be verified against the gain chart. If results other than those specified are obtained, the test must be terminated and the malfunction isolated and repaired. (See figure 8-24 for verification procedure.)

8-29. ACCELEROMETER CALIBRATION REQUIREMENTS.

8-30. An internal resistance measurement of the accelerometer must be made between accelerometer output terminals, using megohmmeter Model 1862B (General Radio), or equivalent, set at a test voltage of 100 vdc. Internal resistance must be greater than 50 megohms. An insulation resistance measurement of the accelerometer must be made between both accelerometer output terminals and accelerometer case using the megohmmeter set at a test voltage of 100 vdc. Insulation resistance must be greater than 50 megohms.

8-31. An accelerometer and a frequency-sensitivity calibration test must be made on a vibration machine capable of applying 25-225g rms to the accelerometer. The accelerometer mounting torque is 16-20 inch-pounds. A total electrical load of 1,650 picofarads, which must include the capacitance of the instrumentation and accelerometer cable, must shunt the accelerometer during calibration tests. The measured capacitance value (C_a) is used in computing the amplifier input voltage and is to be recorded. Capacitance bridge ES1, Model 205DA (Electro-Measurement Inc), or equivalent, may be used in determining accelerometer capacitance.

8-32. All calibration tests must be made at an atmospheric pressure of 28-32 inches of mercury, a temperature of 75° ±5° F, and a relative humidity of 85 percent or less. Equipment used to calibrate the accelerometers must be certified by or traceable to the National Bureau of Standards and must have accuracies within the following tolerances.

a. Vibration amplitude generating accuracy: ±10 percent

b. Vibration amplitude measuring accuracy: ±3 percent

c. Vibration frequency generating accuracy: ±5 percent

d. Vibration frequency measuring accuracy: ±1 percent

e. Voltage measuring accuracy: ±2 percent

f. Capacitance measuring accuracy: ±1 percent

Sensitivity Control Dial Setting							
1000		750		500		250	
Input Voltage (Amplitude)	Accelerometer Attenuator Dial Setting	Input Voltage (Amplitude)	Accelerometer Attenuator Dial Setting	Input Voltage (Amplitude)	Accelerometer Attenuator Dial Setting	Input Voltage (Amplitude)	Accelerometer Attenuator Dial Setting
--	1000	--	1000	--	1000	--	1000
--	800	--	800	--	800	--	800
--	600	--	600	--	600	--	600
--	400	--	400	--	400	--	400
--	200	--	200	--	200	--	200

Figure 8-23. Vibration Safety Cutoff Unit Dial Setting Chart (Typical)

NOTE: The following abbreviations are used in this figure:

Loc Location
SG Signal generator
VSC Vibration safety cutoff panel

Step	Loc	Operation	Loc	Result
1		Obtain the following test equipment (figure 8-12): a. Signal generator b. AC voltmeter		
2		Connect signal generator to vibration safety cutoff unit input receptacle J3.		No visible results
3		Connect ac voltmeter across signal generator output leads.		No visible results
4	SG	Energize signal generator and set at 2,000 ±40 cps and voltage output (amplitude) of zero.	SG	No visible results
5	VSC	Move vibration safety cutoff POWER switch to ON. (Make sure that RESET switch is depressed.)	VSC	ARM light comes on.
6	VSC	Set SENSITIVITY control to dial setting of 1,000.	VSC	No visible results
7	VSC	Set ACCELEROMETER ATTENUATOR control to dial setting of 1,000.	VSC	No visible results

Figure 8-24. Verification of Accelerometer Attenuator and Sensitivity Control Dial Settings (Sheet 1 of 2)

Step	Loc	Operation	Loc	Result
8	SG	Increase signal generator voltage output (amplitude) until cutoff is obtained. Note and record serial number of VSC, SENSITIVITY, and ACCELEROMETER ATTENUATOR control dial settings, and signal generator output voltage (amplitude).	VSC	CUTOFF light comes on. ARM light goes off.
NOTE: ACCELEROMETER ATTENUATOR and SENSITIVITY control dial settings which require signal generator amplitude to be increased beyond 1.8 volts are not applicable to recorded data.				
9	VSC	Repeat steps 6 through 8 with ACCELEROMETER ATTENUATOR control dial settings of 800, 600, 400, and 200 for each SENSITIVITY control dial setting of 750, 500, and 250. Depress RESET switch after setting each new value.	VSC	As indicated in applicable step CUTOFF light goes off and ARM light comes on when RESET switch is depressed.
10		Compare recorded ACCELEROMETER ATTENUATOR and SENSITIVITY control dial settings with existing vibration safety cutoff unit dial setting data at respective input signal (volts) to obtain cutoff at 2,000 cps. Recorded control settings must be within ±5 percent of respective values of previous data. If there is no existing data, proceed to step 11. If recorded control settings are not within specified tolerance, system malfunction must be determined and corrected, and procedure repeated; otherwise replace VSC.		
11		If there is no existing data for comparison, use recorded data (steps 8 and 9) for initial chart, and maintain for subsequent verification checks.		

Figure 8-24. Verification of Accelerometer Attenuator and Sensitivity Control Dial Settings (Sheet 2 of 2)

8-33. ACCELERATION CHECK. The acceleration check requires the accelerometer to be vibrated at a frequency of 1,000 ±200 cps at 30 ±3 g, 60 ±6 g, 100 ±10 g, and 200 ±20 g; the output voltage (V_O) measured; and the axial sensitivity (V_O/g) determined at each force level. Axial sensitivity must be within one percent of the average of the four axial sensitivity results, with a minimum of 5 millivolts per g for Model ES-6412, and a minimum of 4.6 millivolts per g for Model ES-6011 and Model ES-6412A.

8-34. ACCELEROMETER SENSITIVITY CHECK. The frequency sensitivity check requires the accelerometer to be vibrated at 30 ±3 cps, 100 ±10 cps, 1,000 ±100 cps, 3,000 ±300 cps, and 4,000 ±400 cps; at an

acceleration within 5-10g and its output voltage (V_o) measured; and sensitivity (V_o/g) determined at each frequency, with a minimum of 4.6 millivolts per g. Accelerometer ES-6412 must have each of the five resultant sensitivities within 3 percent of the average of the five sensitivity results. This average is the S_s and is used in computing the amplifier input voltage which is to be recorded. Accelerometers ES-6011 and ES-6412A must have each of the five resultant sensitivities within 5 percent of the sensitivity derived at 100 cps.

8-35. AMPLIFIER CALIBRATION REQUIREMENTS.

8-36. Calibration of the isolator amplifier is not required, since it is adjusted with the set prior to each test.

8-37. REPAIRING VIBRATION SAFETY CUTOFF UNIT ASSEMBLY.

8-38. The vibration safety cutoff unit may be repaired in the field to the extent of replacing fuses, light bulbs, switches, wiring, relays, filter, transformer, potentiometer, and board assemblies 9016225-1 (PCB-1), 9016216 (PCB-2), 9015706 (TB1), 9015708 (TB2), and 9015715.

8-39. A complete functional test of the vibration safety cutoff unit must be performed in accordance with paragraph 8-26 after any repair of the unit.

8-40. PREPARING FOR STORAGE.

8-41. No special instructions are required for storage of the set, except that the vibration safety cutoff unit and isolator amplifier be covered with greaseproof barrier material (MIL-B-121, Grade A), or equivalent, and sealed, and the accelerometer be placed in a protective-lined container.

SECTION IX

PNEUMATIC CONSOLE G5106

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

G1037, Electrical Checkout Console
G3106, Pneumatic Console
G3107, Components Test Console

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9-44	Leak-Testing Flexible Hoses		9-34

9-1. DESCRIPTION AND LEADING PARTICULARS.

9-2. The pneumatic console (figure 9-1) is used to provide regulated pressures, monitor pressures, and measure leakage rates for engine systems and components during leak- and function-tests of J-2 rocket engine. The console is capable of providing regulated pneumatic pressures up to 3,000 psig, monitoring pressures up to 600 psig, and measuring flowrates of 0.75 to 640 scim. The console consists of two cabinets, capable of mounting standard 19-inch panels, attached to a rectangular base. Mounted on front of the console are three pneumatic supply panels, a dual pressure monitor panel, a flowmeter panel, six storage drawers, and a writing shelf. Two access doors and an interface panel are provided at the rear of the console. The interface panel which serves as a connect point between facility supply, console, and engine, and contains a console pressure inlet connection, pressure monitor inlets, pressure outlets, and an electrical connector. A high-pressure filter, relief valve, pressure switch, and three-way solenoid control valve are mounted on the console interior and are connected with the pneumatic supply and interface panel by rigid tubing. The relief valve in the inlet line protects the system from over-pressurization. The pressure switch activates the warning light located on top of the console, indicating that the console is pressurized. The three-way solenoid control valve, connected to the 0-1000 psi pneumatic supply panel and actuated by a signal from the electrical checkout console, allows pressure to actuate the engine pressure-actuated control valve. Provided with and stowed in the console are five flexible hoses used during a self-checkout of the console and during leak- and function-tests of the engine systems. Test kits, installed on the engine systems during leak- and function-tests, are stowed in the storage drawers on the console. For leading particulars of pneumatic console, see figure 9-2. Instructions for the use of the pneumatic console are in R-3825-2 and R-3825-3.

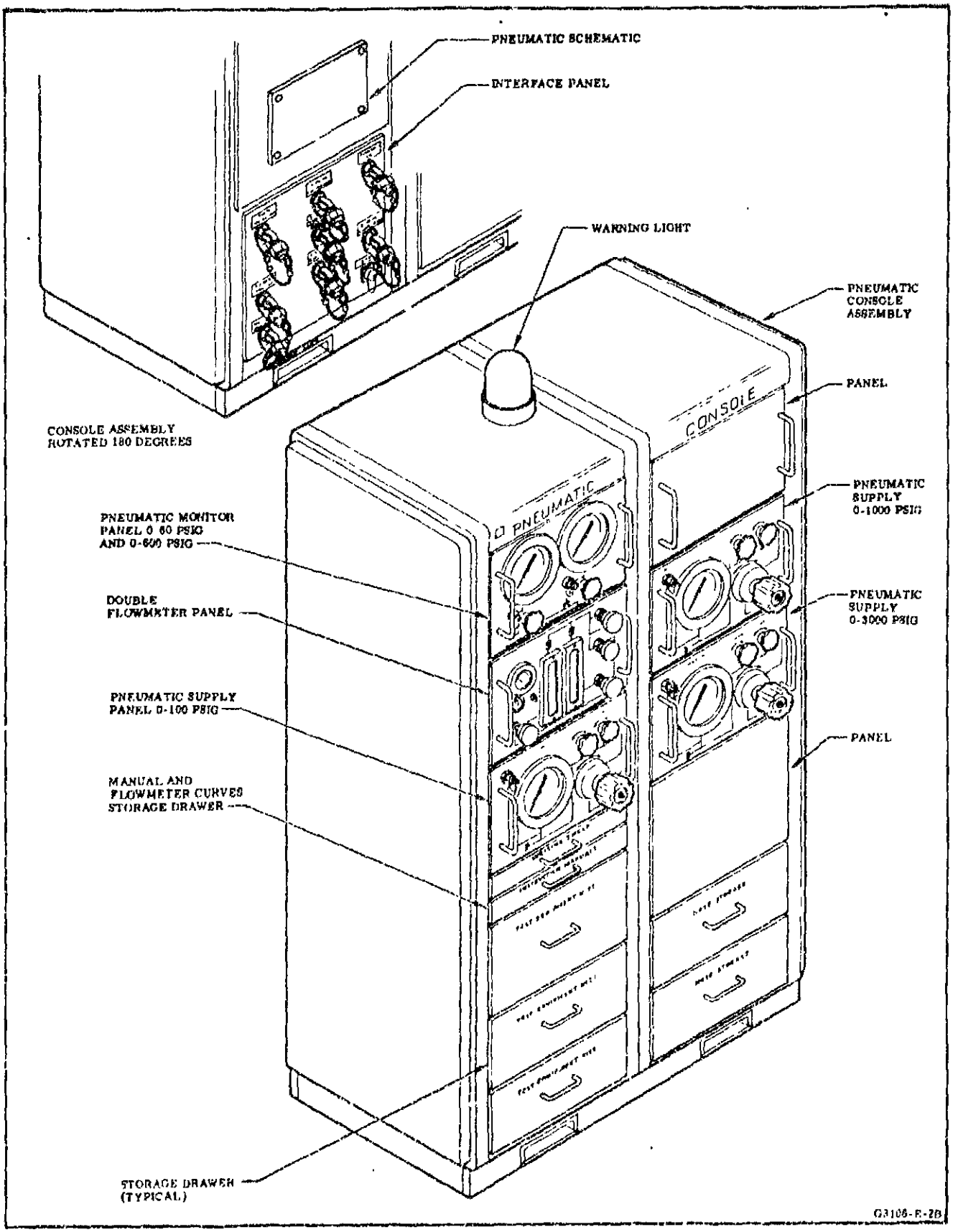

Figure 9-1. Pneumatic Console

Dimensions	
Height	86.50 inches.
Width	46.68 inches.
Depth	26.50 inches.
Weight	700 pounds, approximately.
Handling	Forklift slots in base.
Requirements	
Helium	Refer to section I.
Electrical	28 ±2 vdc.
Facility Cable	Pin A positive, Pin B ground, Pin C negative, and Pin D to a two-way switch which is also wired to positive wire. P1 connector MS3106R18-1S.
Performance	
Operating Pressure	0 to 3,000 psig (3,200 psig maximum).
Flow Measuring	0.75 to 640 scim at 30 psig.
Protection Devices	
Relief Valve	
Relief Pressure	3,350 ±175 psig.
Flow at 125% Relief Pressure	2,000 scim.
Warning Light Pressure Switch	
Actuation Setting	75 ±25 psig.
Filtration	
High-Pressure Filter	
Rating	18-micron absolute (5-micron nominal).
Flowrate	10 scfm at 1,500 psig.
Pressure Drop	3 psig at 1,500 psig.

Figure 9-2. Leading Particulars for Pneumatic Console

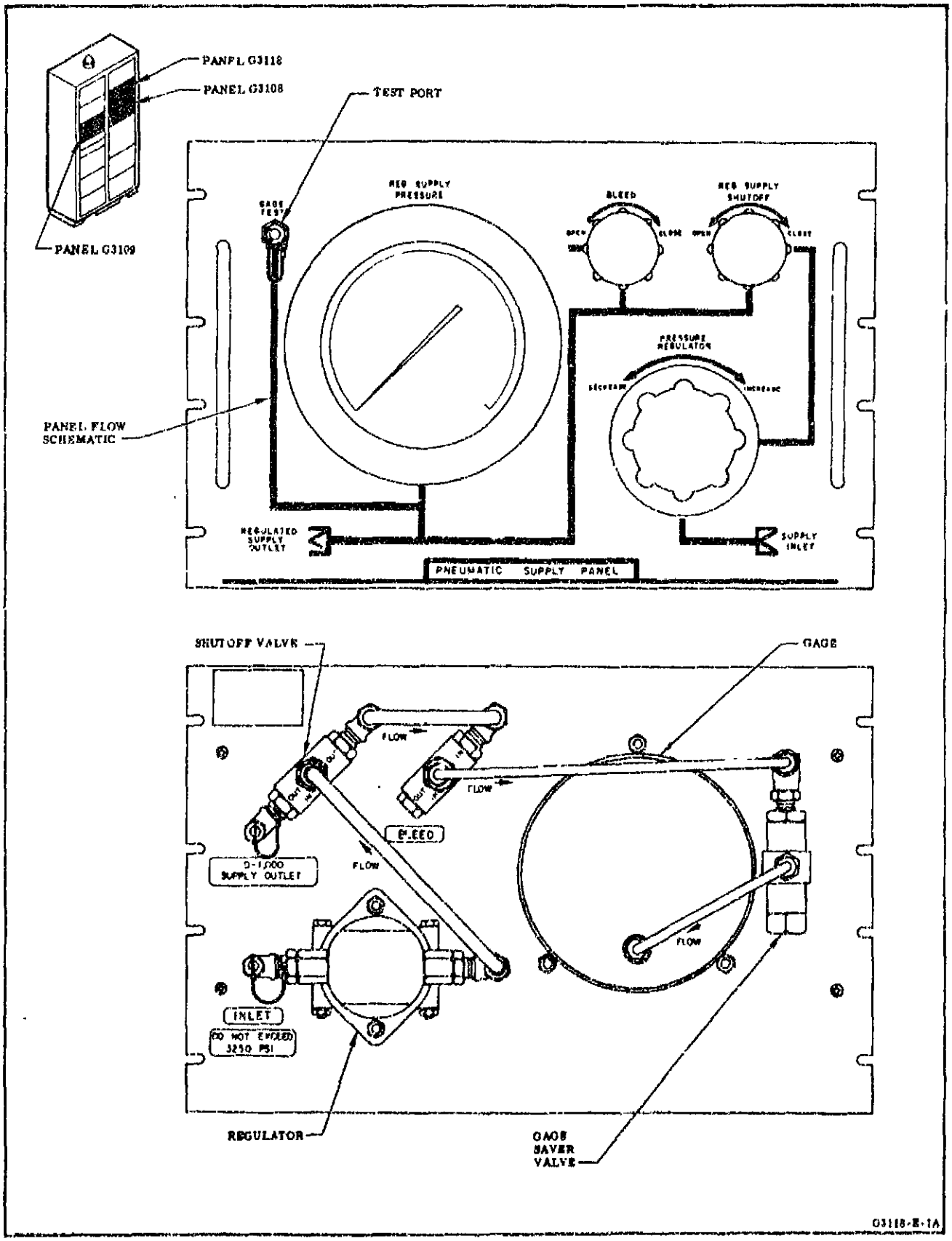

Figure 9-3. Pneumatic Supply Panels (Typical)

9-3. PNEUMATIC SUPPLY PANELS.

9-4. The pneumatic console contains three similar pneumatic supply panels (figure 9-3) which vary in the ranges of pressure regulation. Panel G3109 supplies regulated pressure in a range of 0-100 psig; panel G3118, a range of 0 to 1,000 psig; and panel G3108, a range of 0 to 3,000 psig. The panels are capable of regulating console pressure and supplying it to various engine systems. The panels contain a pressure regulator, shutoff valve, bleed valve, pressure gage, gage saver, inlet port, outlet port, test port, and interconnecting tubing. For leading particulars of console panels, see figure 9-4.

Dimension	
Panel Face	19 by 12 inches.
Pressure Rating	
Shutoff Valve	0 to 3,000 psig.
Bleed Valve	0 to 3,000 psig.
G3109 Panel	
Regulator	0-100 psig.
Gage	0-100 psig; ±0.25% accuracy.
Gage Saver Setting	105 ±5 psig.
G3118 Panel	
Regulator	50 to 1,000 psig.
Gage	0 to 1,000 psig; ±0.25% accuracy.
Gage Saver Setting	1,050 ±5 psig.
G3108 Panel	
Regulator	500 to 3,000 psig.
Gage	0 to 3,000 psig; ±0.25% accuracy.
Gage Saver Setting	3,150 ±150 psig.

Figure 9-4. Leading Particulars for Pneumatic Supply Panels

9-5. PNEUMATIC MONITOR PANEL.

9-6. The pneumatic monitor panel G3103 (figure 9-5) is a dual monitor system capable of monitoring pressures of 0-60 psig and 0-600 psig during leak-tests of the engine systems. The panel contains a 0-60 psi pressure gage and a 0-600 psi pressure gage, two gage savers, two bleed valves, two inlet and test ports, and interconnecting tubing. Both gages have a ±0.25% accuracy. The gage saver setting for the 0-60 psig gage is 63 ±3 psig; for the 0-600 gage it is 630 ±30 psig.

9-7. FLOWMETER PANEL.

9-8. The flowmeter panel (figure 9-6) is designed to measure helium flowrates of 0.75 to 640 scim at 30 psig. The flowmeter panel contains two needle valves, two check valves, two double-float flowmeters, a bypass valve, a bleed valve, a thermocouple, a gas temperature gage, a pressure gage, a relief valve, a filter, a single-pole single-throw switch, and a light installed in each flowmeter. The double-float increases the range of the flowmeter because of the increased volume required to raise the heavier float. For leading particulars of the flowmeter panel, see figure 9-7.

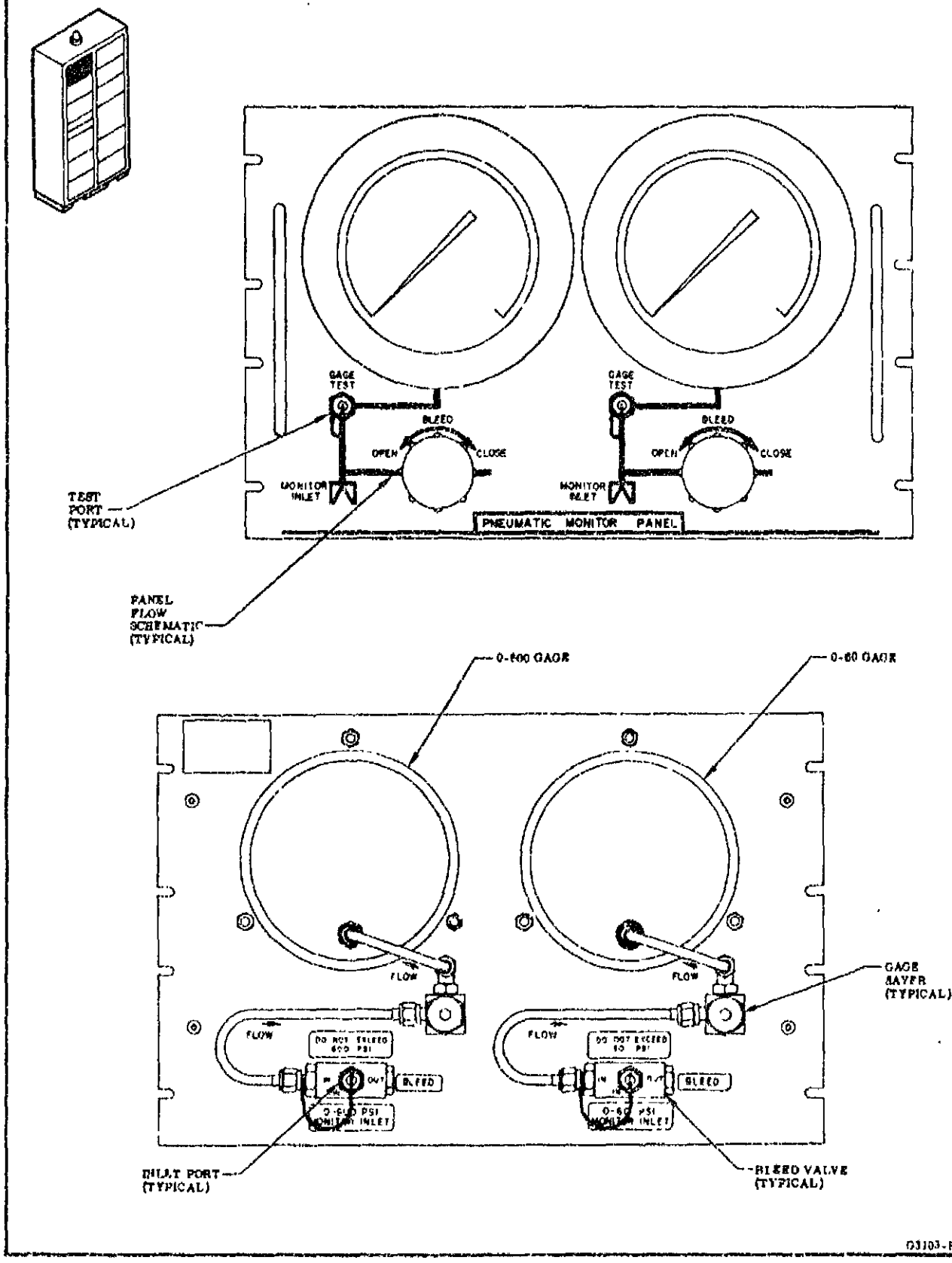

Figure 9-5. Pneumatic Monitor Panel

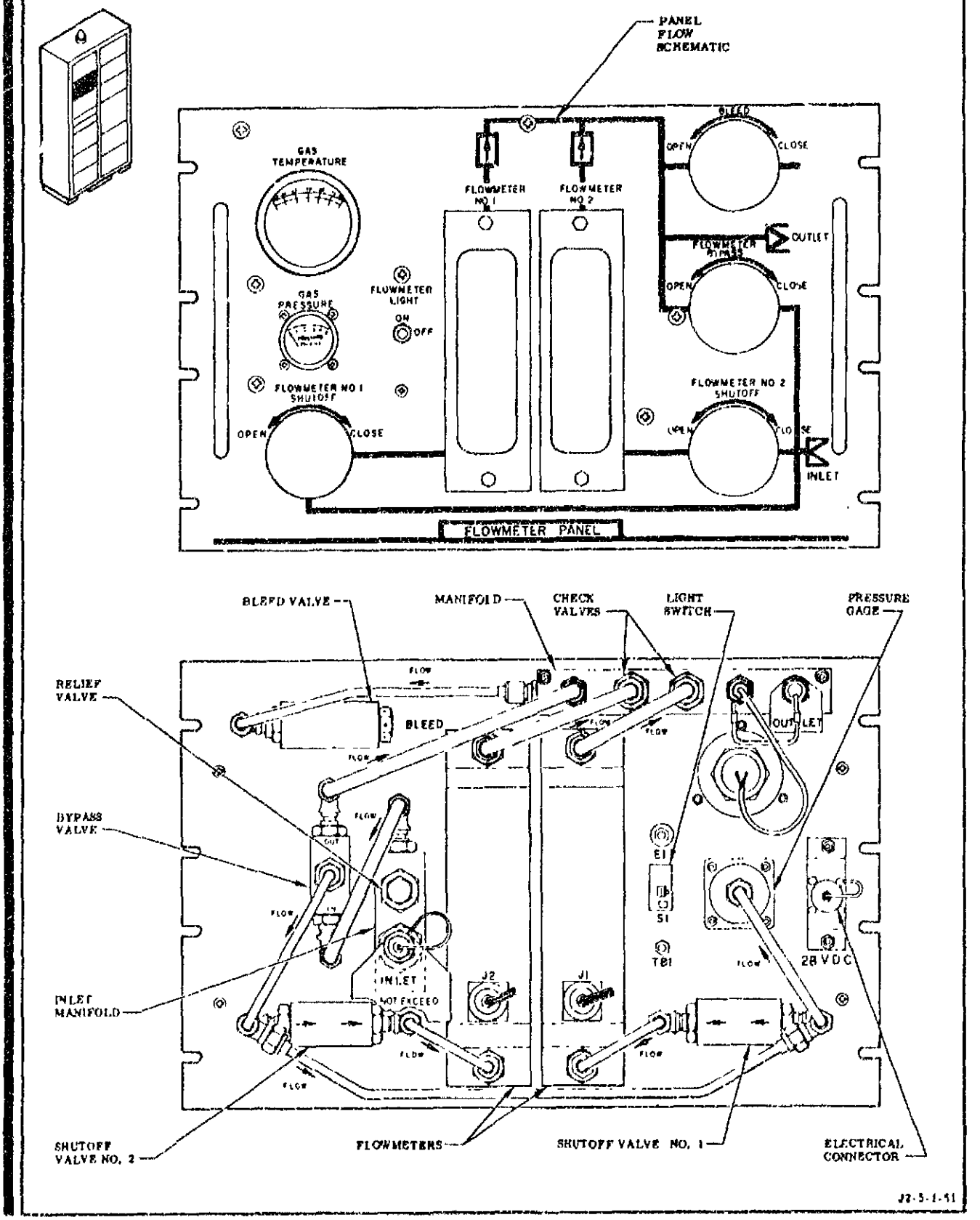

Figure 9-6. Flowmeter Panel

Flowrate	
Flowmeter No. 1	
Upper Float	0.75 to 7.5 scim at 30 psig.
Lower Float	4.95 to 49.5 scim at 30 psig.
Flowmeter No. 2	
Upper Float	20-200 scim at 30 psig.
Lower Float	64-640 scim at 30 psig.
Accuracy	10% of full scale.
Operating Pressure	500 psig, maximum.
Operating Temperature Range	+40° to +125° F.
Gas Temperature Gage Range	-75° to +225° F.
Gas Pressure Gage	0-500 psig; ±0.5% accuracy.
Check Valves	0.72 psig cracking pressure.
Relief Valve	537 ±27 psig.
Filter	18-micron absolute (5-micron nominal).

Figure 9-7. Leading Particulars for Flowmeter Panel

9-9. ACCESSORIES.

9-10. Accessories (figure 9-8) for the pneumatic console consist of flexible interconnect hoses and test kits used for engine testing. Five storage drawers are provided in the console for storage of accessories.

Part Number	Nomenclature	Quantity
9016701	Bypass duct test plate kit	1
9016710	Hot-gas exhaust test plate kit	1
9016711-21	Fuel turbine torquing wrench kit	1
9016712-11	Accessory drive oxidizer turbine torquing wrench kit	1
9016713	Turbopump inlet ducts test plate kit	1
9016719	Customer connect 30-psig test plate kit	1
9016723-11	Bypass valve actuation test plate kit	1
9016724	Customer connect 250-psig test plate kit	1
9017259	Accessory drive shaft oxidizer turbine torquing wrench	1
9017273	Customer connect 500-psig test plate kit	1
9017274	Customer connect 2,000-psig test plate kit	1

Figure 9-8. Accessories (Sheet 1 of 2)

Part Number	Nomenclature	Quantity
9018835[a]	Pressure actuated valve test plate kit	1
9018840	Customer connect 30-psig test plate kit	1
9018843-11	Customer connect 80-psig test plate kit	1
9018846	Accessory drive pad leak-test plate kit	1
9020266	Customer connect oxidizer tank test plate kit	1
9020269	Bypass valve removal tool kit	1
9020784-11	Oxidizer dome purge shutoff plug kit	1
9024494	Oxidizer turbopump seal cavity drain line kit	1
9024496	Oxidizer and fuel turbine drain line kit	1
9024497	Augmented spark igniter and gas generator oxidizer purge test kit	1
9024718	Metering valve kit	1
9025400	Pressure-actuated purge valve test kit	2
9025405	Calibration pressure switches test adapter kit	1
9025419	Fuel pump leak and flow adapter kit	1
9025817[b]	Turbopump oxidizer seal cavity adapter kit	1
19-9019556-2 682108-6-2400[c]	Helium inlet 3, 200 psig supply pressure flexible hose	1
19-9019556-1 646817-4-2400[c]	Flexible test hose	4

(a) On consoles not incorporating MD6 change
(b) On consoles incorporating MD9 change
(c) Allowable alternate

Figure 9-8. Accessories (Sheet 2 of 2)

9-11. THEORY OF OPERATION

9-12. The pneumatic console is designed to perform leak- and function-tests of engine systems. The console is connected to the engine systems, the facility helium supply, and 28 vdc power by flexible hoses and electrical cable. Supplying facility pneumatic pressure and 28 vdc power to the interface panel connect points allows pneumatic pressure to flow to the inlet port of each pneumatic supply panel regulator and actuates the pressure switch which illuminates the console warning light. Adjusting the pressure regulator towards increase and opening the regulator shutoff valve permits pneumatic pressure to flow through the

supply panel and to the engine systems under test. When the flowmeter panel inlet, connected directly to the pneumatic supply panel (0-100) outlet line, is pressurized, the pneumatic pressure flowing through the flowmeter can be measured. Energizing the three-way solenoid operated valve, connected to the pneumatic supply panel (0-1000) and electrically operated from Electrical Checkout Console G1037, allows pneumatic pressure to operate the engine-mounted pressure-actuated control valve. After completion of the tests, when a small volume of gas is to be bled, the engine system is depressurized by turning the pressure regulator towards decrease. When a large volume of gas is to be bled, the regulator supply shutoff valve is closed, the bleed valve is opened, then the regulator is turned towards decrease. The pneumatic pressure begins to vent when the pressure regulator is turned twice in a counterclockwise direction and continues to vent as long as the regulator is being turned counterclockwise. If a pressure monitor panel is used during the operation, the pneumatic system must be vented by opening the bleed valve on the monitor panel, allowing pneumatic pressure to bleed downstream of the system.

9-13. The flowmeters are pressurized by the pneumatic supply panel (0-100). Pneumatic pressure is introduced into the flowmeter system where it is filtered through a five-micron filter and distributed to the relief valve, flowmeter bypass valve inlet, flowmeter No. 1 shutoff valve inlet, flowmeter No. 2 shutoff valve inlet, and gas pressure gage. This gage only indicates that pressure is supplied to the flowmeter panel. The flowmeters are connected to the engine system by the use of a flexible hose supplied with the console. Opening the flowmeter bypass valve allows pneumatic pressure to flow to the engine system, pressurizing the engine system to the required pressure. After the engine system is pressurized, the flowmeter bypass valve is closed and flowmeter No. 2 shutoff valve or flowmeter No. 1 shutoff valve is slowly and fully opened, selecting the flowmeter applicable to the rate of leakage to be measured. If leakage is present in the engine system, the floats in the flowmeter tube rise and stabilize at a point on the flowmeter scale, indicating the amount of leakage in scim. The temperature of the gas flowing through the flowmeter, as indicated on the temperature gage, and the indicated leakage observed on the flowmeter are then applied to the flowmeter correction curves supplied with the pneumatic console. These readings are plotted on the correction curves as outlined in section X and the result is the total corrected amount of scim leakage in the engine system. After completion of the leak-test, the engine system is vented by closing flowmeter No. 1 shutoff valve and flowmeter No. 2 shutoff valve, shutting off the supply of pneumatic pressure to the flowmeter panel, then opening the bleed valve.

9-14. The pneumatic monitor panel is connected to the engine systems by flexible hoses supplied with the console. During leak- and function-tests, pneumatic pressure flows from the engine system to the monitor pressure gages. After completion of leak- and function-tests, pneumatic pressure is vented by opening the bleed valve at the monitor panel.

9-15. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

9-16. Modifications incorporated changing the configuration of the pneumatic console are listed in figure 9-9.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-149	1	30 July 1964
J2-175	2	30 July 1964
J2-176	3	30 July 1964
J2-220	4	30 July 1964
J2-223	5	30 July 1964
J2-304	6	2 November 1964
J2-309	7	21 May 1965
J2-336	8	21 June 1965
J2-343	9	21 June 1965
J2-343R1	9	N/A
J2-375	10	21 September 1965
J2-402	11	21 September 1965
J2-420	12	7 January 1966
J2-448	13	17 February 1966

Figure 9-9. Configuration Changes--Manual Effectivity

9-17. MAINTENANCE OF PNEUMATIC CONSOLE.

9-18. Maintenance tasks required on the pneumatic console are listed in figure 9-10. Information presented lists the tasks to be performed, when the tasks must be performed, and reference to data necessary to accomplish these tasks.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect console for completeness.	X	X			Refer to paragraph 9-9.
Inspect electrical cables for broken wiring or insulation and for cracked or damaged terminal boards or connectors.	X	X			Replace damaged electrical cables or terminal boards. See figures 9-18 and 9-19.
Inspect console interior and exterior surfaces and electrical cables for cleanness.	X	X			Clean. Refer to Cleaning in section I.
Inspect flexible hoses for contamination	X	X			Clean flexible hoses. Refer to section I.
Paint pneumatic supply, flowmeter, and monitor panels.				X	When painted surfaces are damaged. Paint with enamel (Federal Specification TT-E-529); color 26440 (Federal Standard 595).
Paint console.				X	When painted surfaces are damaged. Paint surface with gray enamel (Stantron), or equivalent.
Clean pneumatic components.				X	As required to maintain cleanness. Refer to Cleaning in section I.
Replace filters.				X	Every 12 months.
Check pressure gages for accuracy.				X	Every 6 months. Refer to paragraph 9-23.
Check flowmeters for accuracy.	X			X	Every 6 months. Refer to paragraph 9-24.
Check gas temperature gage for accuracy.	X			X	Every 6 months. Refer to paragraph 9-25.
Leak- and function-test pneumatic console.	X			X	Every 6 months. Refer to paragraph 9-19.
Proof-pressure-test flexible hoses.				X	Every 6 months. Refer to paragraph 9-42.
Leak-test flexible hoses.				X	Every 6 months, subsequent to proof-pressure-test of flexible hoses. Refer to paragraph 9-44.

Figure 9-10. Maintenance Requirements

9-19. LEAK- AND FUNCTION-TESTING.

9-20. Leak- and function-testing of pneumatic console consists of testing pressure switch, relief valve, pressure regulator, gage savers, supply panels, monitor panel, and flowmeter panel. Test equipment required to perform the leak- and function-test is listed in figure 9-11. See figure 9-15 for console pneumatic schematic and figures 9-17 and 9-18 for console and flowmeter panel electrical wiring diagrams. To supply electrical power to console, it may be necessary to fabricate a power supply test cable (figure 9-12) or use Electrical Checkout Console G1037.

NOTE

Testing the console requires checking relief valves for proper relief pressures. One of the relief valves has a relief pressure of 3, 350 ±175 psig, which is above the operating pressure of the console. The valve may, at the option of personnel performing the test and with adequate safeguards, be tested while installed in the console. Applying pressures above the operating range of the console is permissible, with adequate safety measures, since the console has been proof-tested to 4, 500 psig. A minimum regulated source of 3, 600 psig of helium pressure must be available to the console to test the valve while installed. If the operator chooses not to test the valve while installed, it must be removed, checked to the requirements of steps r and s, and re-installed prior to beginning this test.

a. Remove relief valve from flowmeter panel (figure 9-6).

b. Place relief valve in a test setup capable of supplying 570 psig minimum of pneumatic pressure, using 0-800 psi test gage and shutoff valve shown in figure 9-11. Components Test Console G3107 may be used for test.

c. Slowly pressurize test setup until relief valve vents, or test gage indicates 570 psi maximum. Relief valve must vent at 537 ± 27 psig. Refer to paragraph 9-40 to adjust relief valve.

d. Slowly decrease test pressure to 400 psig, then increase pressure to 480 ±5 psig. Relief valve must reseat with no leakage.

e. Depressurize test setup, remove test equipment, and install relief valve in flowmeter panel.

Part No. or Specification	Nomenclature	Use
	0-5,000 psi test gage, with a ±0.5% accuracy. 50-psi increments maximum.	Tests high-pressure relief valve and 0-3,000 psi gage
	0-1,500 psi test gage, with a ±0.5% accuracy. 10-psi increments maximum.	Tests 0-1,000 psi gage saver.
	0-800 psi test gage, with a ±0.5% accuracy. 10-psi increments maximum.	Tests 0-630 psi gage saver and flowmeter panels relief valve.
	0-160 psi test gage, with a ±0.5% accuracy. One-psi increment maximum.	Tests 0-100 psi gage saver and pressure switch.
	0-100 psi test gage, with a ±0.5% accuracy. One-psi increment maximum.	Tests 0-63 psi gage saver.
	Shutoff valve, 4,500-psi working pressure.	Vents pressure during leak- and function-testing.
G3107(a)	Pneumatic Test Console	Tests relief valves.
G1037(a)	Electrical Checkout Console	Supplies electrical power and actuates console solenoid valve.
Refer to Section I	Helium, 3,600 psig.	Leak- and function-tests console.
MIL-T-25567	Leak-test compound	Detects leakage.

(a) Used as alternate test equipment.

Figure 9-11. Test Equipment and Materials

f. Ensure that all valves, regulators and switches on the console are at CLOSE, DECREASE, or OFF positions.

g. Ensure that all pressure connections not used are pressure-capped.

h. Connect electrical checkout console and electrical cable 19-9019656, or 28 vdc power supply test cable (figure 9-12), between connector J-1 on interface panel and 28 vdc facility supply.

i. Connect 0-160 psi gage and shutoff valve (figure 9-11) between interface panel HE INLET 3200 PSI MAX and facility helium supply.

j. Energize facility 28-vdc power. When using electrical checkout console perform the following:

(1) Connect console to facility power supply.

(2) Depress 28 VDC POWER circuit breaker on GROUND RELAY panel.

(3) Depress ENGINE POWER circuit breaker on ENGINE CONTROL panel.

(4) Move switch below ENGINE GROUND POWER light on ENGINE CONTROL panel to ON.

k. Slowly open facility supply and pressurize console pneumatic system until console warning light comes on. The 0-160 psi gage indicates 110 psi maximum.

l. Close facility supply and vent pneumatic system. Warning light goes off. Remove test equipment.

m. Connect flexible hose 682108-6-2400 between facility gaseous helium supply and HE INLET 3200 PSI MAX connection.

n. Slowly open facility supply valve and pressurize console pneumatic system to 3,150 ± 150 psig. Check for audible leakage. Proceed to step p if no audible leakage exists.

o. Depressurize system and correct leaks. Refer to section I for torque values. Repeat steps n and o until audible leakage has been corrected.

WARNING

Loosening, removing, or repairing high-pressure lines before the system is completely depressurized can cause the lines to whip, resulting in serious injury to personnel and damage to equipment.

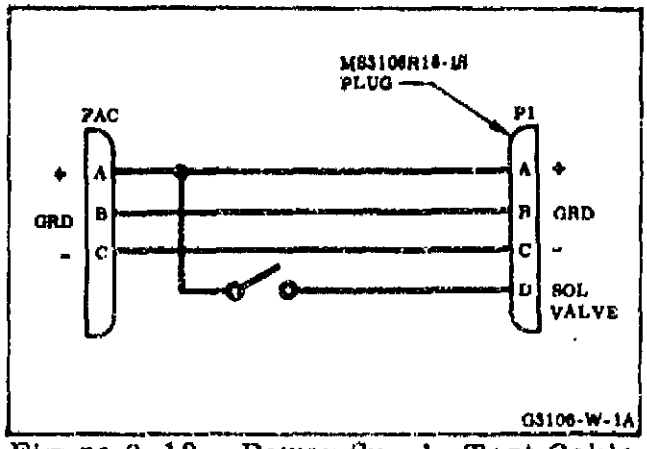

Figure 9-12. Power Supply Test Cable

p. Apply leak test compound to all fittings and components from HE INLET 3200 PSI MAX. fitting to INLET connections of PNEUMATIC SUPPLY PANEL (0-100), PNEUMATIC SUPPLY PANEL (0-1000), and PNEUMATIC SUPPLY PANEL (0-3000). No leakage is allowable.

q. Ensure REG SUPPLY SHUTOFF valves on all 3 PNEUMATIC SUPPLY PANELS are at maximum DECREASE and open BLEED valves.

r. Slowly increase facility supply pressure until relief valve vents or facility pressure gage indicates 3,600 psig minimum. Relief valve must vent at 3,350 ±175 psig. Refer to paragraph 9-38 to adjust relief valve.

s. Decrease facility supply pressure. Relief valve shall reseat at 2,900 psig minimum.

t. Increase facility supply pressure to 3,150 ±150 psig. Close BLEED valves on all three PNEUMATIC SUPPLY PANEL.

NOTE

Gage savers are tested by overpressurizing several times, checking the pressure and repeatability of pressure at which they operate (shutoff). The pneumatic console can be used to test all gage savers except the one installed in the 0-3000 pneumatic supply panel. Over-pressurizing gage savers is accomplished by interconnecting a higher pressure supply system to the gage saver being tested.

u. Disconnect tube assembly from outlet port of gage saver to be tested, column I (figure 9-13). Connect the appropriate test gage and vent shutoff valve (figure 9-11) to gage saver outlet port.

v. Connect a flexible hose 646817-4-2400 between applicable test ports of panels specified under column II of figure 9-13.

NOTE

A regulated external source capable of supplying a minimum of 3,600 psig is required to test gage saver in pneumatic supply panel (0-3000).

w. On panel being used to supply pressure (figure 9-13), open REG SUPPLY SHUTOFF valve and slowly turn PRESSURE REGULATOR to INCREASE until REG SUPPLY GAGE indicates pressure specified in column III of figure 9-13.

x. Apply leak-test compound to the test equipment connected to gage saver. No leakage is allowable.

y. Record pressure indicated on test gage connected to gage saver. Pressure must be within setting specified in column IV of figure 9-13.

z. Close REG SUPPLY SHUTOFF valve and open BLEED valve on applicable panel. After pressure decays, close bleed valve.

aa. Repeat steps w, y, and z three times. If gage saver fails test (actuates closed outside limit listed in column IV of figure 9-13) and difference between highest and lowest pressures at which gage saver actuated closed did not exceed value listed in column V of figure 9-13, adjust gage saver (paragraph 9-34) and repeat steps w through aa.

NOTE

Adjusting the gage saver is not considered practical if the range at which the gage saver actuates exceeds noted limits.

ab. Open REG SUPPLY SHUTOFF valve on applicable panel. Test gage indicates gage saver setting in column IV.

I Gage Saver Location	II Test Hose Connection Between Test Ports	III Applied Pressure (psig)	IV Gage Saver Setting (psig)	V Readjustment Limit (psig)
Pneumatic Supply Panel (0-3000)	0-3000 panel gage test port and external source supply 0-3600 psig.	3,500 ±100	3,150 ±150	300
Pneumatic Supply Panel (0-1000)	0-3000 panel gage test[(a)] port and 0-1000 panel gage test port.	1,170 ±30	1,050 ±50	100

(a) Panel used for supplying pressure.

Figure 9-13. Gage Savers Test Requirements (Sheet 1 of 2)

I Gage Saver Location	II Test Hose Connection Between Test Ports	III Applied Pressure (psig)	IV Gage Saver Setting (psig)	V Readjustment Limit (psig)
Pneumatic Monitor Panel (0-600)	0-1000 panel gage test[a] port and 0-600 panel gage test port	700(+20,-0)	630 ±30	60
Pneumatic Supply Panel (0-100)	0-1000 panel gage test[a] port and 0-100 panel gage test port	117 ±3	105 ±5	10
Pneumatic Monitor Panel (0-60)	0-100 panel gage test[a] port and 0-60 panel gage test port	70(+2,-0)	63 ±3	6

(a) Panel used for supplying pressure.

Figure 9-13. Gage Savers Test Requirements (Sheet 2 of 2)

ac. Slowly pressurize gage saver to pressure specified in column III by opening applicable REG SUPPLY SHUTOFF valve.

ad. Open vent shutoff valve installed on gage saver and allow all pressure to vent from gage saver outlet port. Disconnect test equipment from outlet port of gage saver.

WARNING

The system upstream of gage saver is pressurized. Loosening connections upstream of gage saver can cause serious injury to personnel and damage to equipment.

ae. Apply leak-test compound to outlet port of gage saver. No leakage is allowable.

CAUTION

Leak-test compound must not enter gage saver.

af. Close REG SUPPLY SHUTOFF valve and open BLEED valve. After pressure vents, close BLEED valve.

ag. Turn PRESSURE REGULATOR to maximum DECREASE. REG SUPPLY gage indicates zero.

ah. Connect tube assembly to outlet port gage saver. Refer to section I for torque values.

ai. Disconnect test equipment from GAGE TEST ports and install pressure caps.

aj. Repeat steps u through ai on remaining PNEUMATIC SUPPLY PANEL and PNEUMATIC MONITOR PANEL gage savers.

ak. Perform the following regulator test on PNEUMATIC SUPPLY PANEL 0-3000, PNEUMATIC SUPPLY PANEL 0-1000, and PNEUMATIC SUPPLY PANEL 0-100:

NOTE

The pressure regulator must function smoothly with no erratic changes in pressure throughout its entire operating range.

(1) Apply a hand-force to PRESSURE REGULATOR adjusting knob in column I (figure 9-14) in the direction parallel to and in line with centerline of regulator. No leakage is allowable from regulator vent port. If leakage exists, replace regulator.

(2) Open applicable REG SUPPLY SHUTOFF valve.

(3) Turn PRESSURE REGULATOR toward INCREASE and to maximum REG SUPPLY PRESSURE gage indication. Regulator must not have a constant bleed. If regulator fails, adjust regulator (paragraph 9-36).

(4) Turn PRESSURE REGULATOR to maximum DECREASE. REG SUPPLY PRESSURE gage indicates zero pressure. Downstream pressure must be completely vented.

(5) Turn PRESSURE REGULATOR toward INCREASE until applicable test pressure in column II is indicated on REG SUPPLY PRESSURE gage.

(6) Turn PRESSURE REGULATOR toward DECREASE the applicable number of turns in column III. Regulator must start venting within applicable number of turns in column IV. Pressure must vent and stabilize at a reduced pressure. If regulator fails, adjust regulator (paragraph 9-36).

(7) On PNEUMATIC SUPPLY PANEL (0-3000), turn PRESSURE REGULATOR toward INCREASE until REG SUPPLY PRESSURE gage indicates 3,000 psi.

(8) On PNEUMATIC SUPPLY PANEL (0-3000), turn PRESSURE REGULATOR toward maximum DECREASE until REG SUPPLY PRESSURE gage indicates zero. Regulator must not have a constant bleed at any point. If regulator fails, adjust regulator (paragraph 9-36).

I Regulator Location	II Regulator Test Pressure	III Maximum Regulator Turns to Vent	IV Regulator Turns to Start Venting
Pneumatic Supply Panel (0-3000)	2,500	5	2-4
Pneumatic Supply Panel (0-1000)	1,000	4	1-3
Pneumatic Supply Panel (0-100)	100	3	1-2

Figure 9-14. Pressure Regulator Test Requirements

al. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100) and slowly adjust PRESSURE REGULATOR to INCREASE until 100 psi is indicated on REG SUPPLY PRESSURE gage. GAS PRESSURE gage on FLOWMETER PANEL indicates 100 psi.

am. Apply leak-test compound to all fittings and components from INLET of PNEUMATIC SUPPLY PANEL (0-100), to 0-100 PSI SUPPLY OUTLET on interface panel, and to FLOWMETER PANEL BYPASS INLET, FLOWMETER NO. 1 SHUTOFF valve inlet, FLOWMETER NO. 2 SHUTOFF valve inlet, and GAS PRESSURE gage inlet. No leakage is allowable.

an. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100) and turn PRESSURE REGULATOR to maximum DECREASE.

ao. Open BLEED valve on PNEUMATIC SUPPLY PANEL (0-100) until REG SUPPLY PRESSURE gage indicates zero, then close BLEED valve.

ap. Install flexible hose 646817-4-2400 between 0-100 SUPPLY OUTLET and 0-60 PSI MONITOR INLET ports.

aq. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100) and adjust PRESSURE REGULATOR to INCREASE until 0-60 gage on PNEUMATIC MONITOR PANEL indicates 60 psi.

ar. Apply leak-test compound to all fittings and components between 0-60 PSI MONITOR INLET and 0-60 psi monitor pressure gage. No leakage is allowable.

as. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100) and turn PRESSURE REGULATOR to maximum DECREASE.

at. Slowly open BLEED valve below 0-60 psi gage on PNEUMATIC MONITOR PANEL (0-100) until REG SUPPLY PRESSURE gage and 0-60 psi gage indicate zero, then close BLEED valve.

au. Disconnect flexible hose from 0-60 PSI MONITOR INLET and 0-100 SUPPLY OUTLET ports. Install pressure caps.

av. Connect vent valve and 0-1,500-psi test gage (figure 9-11) to 0-1,000 PSI SUPPLY OUTLET SOLENOID port on interface panel. Open vent valve.

aw. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000) and adjust PRESSURE REGULATOR to INCREASE until REG SUPPLY PRESSURE gage indicates 1,000 psi.

ax. Apply leak-test compound to all fittings and components from INLET of PNEUMATIC SUPPLY PANEL (0-1000) to 0-1,000 PSI SUPPLY OUTLET and 0-1,000 PSI SUPPLY OUTLET SOLENOID ports on interface panel. No leakage is allowable.

ay. Close vent valve installed on 0-1,000 PSI SUPPLY OUTLET SOLENOID port.

az. Energize switch located on power supply test cable. The 0-1,500 psi test gage indicates 1,000 ±100 psi, indicating that solenoid valve is actuated. When using electrical checkout console, perform the following to energize solenoid valve:

(1) Depress TEST POWER circuit breaker on ENGINE CONTROL panel.

(2) Turn TEST/FIRE SELECT switch on GROUND RELAY panel to OK TO TEST.

(2A) Move switch on SIMULATOR panel to FACILITY READY.

(3) Move switch immediately above COMPONENTS TEST light down (toward COMPONENTS TEST light), on ENGINE TEST/MONITOR panel.

(4) Move MAINSTAGE INITIATED switch on ENGINE TEST/MONITOR panel to ON. The 0-1,500 psi test gage indicates 1,000 ±100 psi.

ba. Apply leak-test compound to all fittings from solenoid valve to 0-1,000 PSI SUPPLY OUTLET SOLENOID port. No leakage is allowable.

bb. Deenergize solenoid valve by actuating switch on power supply test cable or MAINSTAGE INITIATED switch on ENGINE TEST/MONITOR panel on electrical checkout console to off position. Solenoid valve vents. The 0-1,500 psi test gage returns to zero.

bc. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000) and turn PRESSURE REGULATOR to maximum DECREASE.

bd. Slowly open BLEED valve until REG SUPPLY PRESSURE gage indication returns to zero, then close BLEED valve.

be. Remove vent valve and 0-1,500 psi test gage connected to 0-1000 PSI SUPPLY OUTLET SOLENOID port and install pressure cap.

bf. Install a flexible hose 646817-4-2400 between 0-1,000 PSI SUPPLY OUTLET and 0-600 PSI MONITOR INLET ports.

bg. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000) and adjust PRESSURE REGULATOR to INCREASE until gage on PNEUMATIC MONITOR PANEL indicates 600 psi.

bh. Apply leak-test compound to all fittings and components from 0-600 PSI MONITOR INLET connection to 0-600 psi MONITOR PRESSURE gage. No leakage is allowable.

bi. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000) and turn PRESSURE REGULATOR to maximum DECREASE.

bj. Slowly open BLEED valve below 0-600 psi gage on PNEUMATIC MONITOR PANEL until REG SUPPLY PRESSURE gage and 0-600 psi gage indicate zero, then close BLEED valve.

bk. Disconnect flexible hose from 0-1,000 PSI SUPPLY OUTLET and 0-600 PSI MONITOR INLET ports. Install pressure caps.

bl. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-3000) and adjust PRESSURE REGULATOR to INCREASE until 3,000 psi is indicated on REG SUPPLY PRESSURE gage.

bm. Apply leak-test compound to all fittings and components from INLET of PNEUMATIC MONITOR PANEL to 0-3,000 PSI SUPPLY OUTLET port on interface panel. No leakage is allowable.

bn. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-3,000) and turn PRESSURE REGULATOR to maximum DECREASE until closed.

bo. Open BLEED valve until REG SUPPLY PRESSURE gage indicates zero, then close BLEED valve.

bp. Move FLOWMETER LIGHT switch to ON. FLOWMETER NO. 1 and FLOWMETER NO. 2 lights come on.

bq. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100) and turn PRESSURE REGULATOR to INCREASE until REG SUPPLY PRESSURE gage indicates 100 (+0, -5) psi.

br. Slowly open FLOWMETER BYPASS valve. Slowly open BLEED valve until audible leakage is heard from BLEED valve outlet, then immediately close BLEED valve.

bs. Close FLOWMETER BYPASS VALVE.

bt. Slowly open FLOWMETER NO. 1 SHUTOFF valve to fully open position. Floats rise momentarily while system is being pressurized and drop to bottom of tube when pressure has stabilized, indicating zero flow.

bu. Check flowmeter floats for freedom of movement by slowly opening and closing BLEED valve. Floats must move freely in tube. Close BLEED valve. Floats must drop to bottom of tube.

bv. Apply leak-test compound to all fittings and components from FLOWMETER NO. 1 SHUTOFF valve to FLOWMETER OUTLET. No leakage is allowable.

bw. Close FLOWMETER NO. 1 SHUTOFF valve, then slowly open BLEED valve. Observe FLOWMETER NO. 1 so that float does not rise above maximum scale reading. Close BLEED valve after venting system.

bx. Open FLOWMETER BYPASS valve. Pressurize system, then close FLOWMETER BYPASS valve.

by. Slowly open FLOWMETER NO. 2 SHUTOFF valve to fully open position. Floats rise momentarily while system is being pressurized and drop to bottom of tube when pressure has stabilized, indicating zero flow.

bz. Check flowmeter floats for freedom of movement by slowly opening and closing BLEED valve. Floats must move freely in tube. Close BLEED valve. Floats must drop to bottom of tube.

ca. Apply leak-test compound to all fittings and components from FLOWMETER NO. 2 SHUTOFF valve to FLOWMETER OUTLET port. No leakage is allowable.

cb. Close FLOWMETER NO. 2 SHUTOFF valve, then slowly open BLEED valve. Observe FLOWMETER NO. 2 so that float does not rise above maximum scale reading. Close BLEED valve after venting system.

cc. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-100), then turn PRESSURE REGULATOR to maximum DECREASE.

cd. Open BLEED valve on PNEUMATIC SUPPLY PANEL (0-100) until REG SUPPLY PRESSURE gage indicates zero, then close BLEED valve.

NOTE

Steps ce through cj are performed to ensure the integrity of the check valves installed downstream of the flowmeters.

ce. Install flexible hose 646817-4-2400 between 0-1000 PSI SUPPLY OUTLET port and FLOWMETER OUTLET port on interface panel.

cf. Open FLOWMETER NO. 1 SHUTOFF valve and FLOWMETER NO. 2 SHUTOFF valve.

cg. Ensure REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY panel (0-100) is closed and open BLEED valve.

ch. Apply tape RB0195-002 (Rocketdyne) on PNEUMATIC SUPPLY PANEL (0-100) bleed valve diffuser. Cover all diffuser ports, then puncture tape at lowest point.

ci. Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000) and turn PRESSURE REGULATOR to INCREASE until 100 (+0, -5) psi is indicated on REG SUPPLY PRESSURE gage.

cj. Apply a film of leak-test compound over hole in tape on bleed valve. There must be no evidence of leakage. If leakage is present, isolate defective check valve by closing FLOWMETER NO. 1 SHUTOFF valve or FLOWMETER NO. 2 SHUTOFF valve. If both SHUTOFF valves are closed and leakage is present, the FLOWMETER BYPASS valve is defective.

CAUTION

Leak-test compound shall not enter bleed valve diffuser.

ck. Close REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-1000).

cl. Slowly open BLEED valve on FLOWMETER PANEL until GAS PRESSURE gage on FLOWMETER PANEL and REG SUPPLY PRESSURE gage on PNEUMATIC SUPPLY PANEL (0-1,000) indicate zero, then close BLEED valve.

cm. Close FLOWMETER NO. 1 SHUTOFF and FLOWMETER NO. 2 SHUTOFF valves. Move FLOWMETER LIGHT switch to OFF. Turn PRESSURE REGULATOR on PNEUMATIC SUPPLY PANEL (0-1,000) to maximum DECREASE.

cn. Disconnect flexible hose connected between 0-1000 PSI SUPPLY OUTLET and flowmeter OUTLET and install pressure caps. Remove tape from PNEUMATIC SUPPLY PANEL (0-100) BLEED valve.

co. Slowly open FLOWMETER PANEL BLEED valve, observing FLOWMETER NO. 1, so that float does not rise above maximum scale reading. Close helium supply pressure at source then open FLOWMETER BYPASS valve.

cp. Close BLEED valve and FLOWMETER BYPASS valve.

cq. (Deleted)

cr. Close facility supply pressure valve.

cs. Open facility vent valve. Console warning light goes off. If vent valve is not provided in the facility system, bleed facility supply pressure as follows:

(1) Open REG SUPPLY SHUTOFF valve on PNEUMATIC SUPPLY PANEL (0-3000).

(2) Open BLEED valve on PNEUMATIC SUPPLY PANEL (0-3000).

(3) Adjust PRESSURE REGULATOR towards INCREASE until facility supply pressure is vented.

(4) Close BLEED valve, REG SUPPLY SHUTOFF valve, and turn PRESSURE REGULATOR towards DECREASE until fully closed.

ct. Disconnect flexible hose between HE INLET 3200 PSI MAX and facility supply and install pressure cap.

cu. Deenergize 28-vdc facility power to pneumatic console. When using electrical checkout console, move all switches to OFF and pull out circuit breakers.

cv. Remove electrical cable assembly from 28-vdc connector J-1 and install protective cap.

cw. Ensure all ports on rear connection panel are capped.

cx. Ensure all valves are turned to CLOSE and regulators are turned to maximum DECREASE.

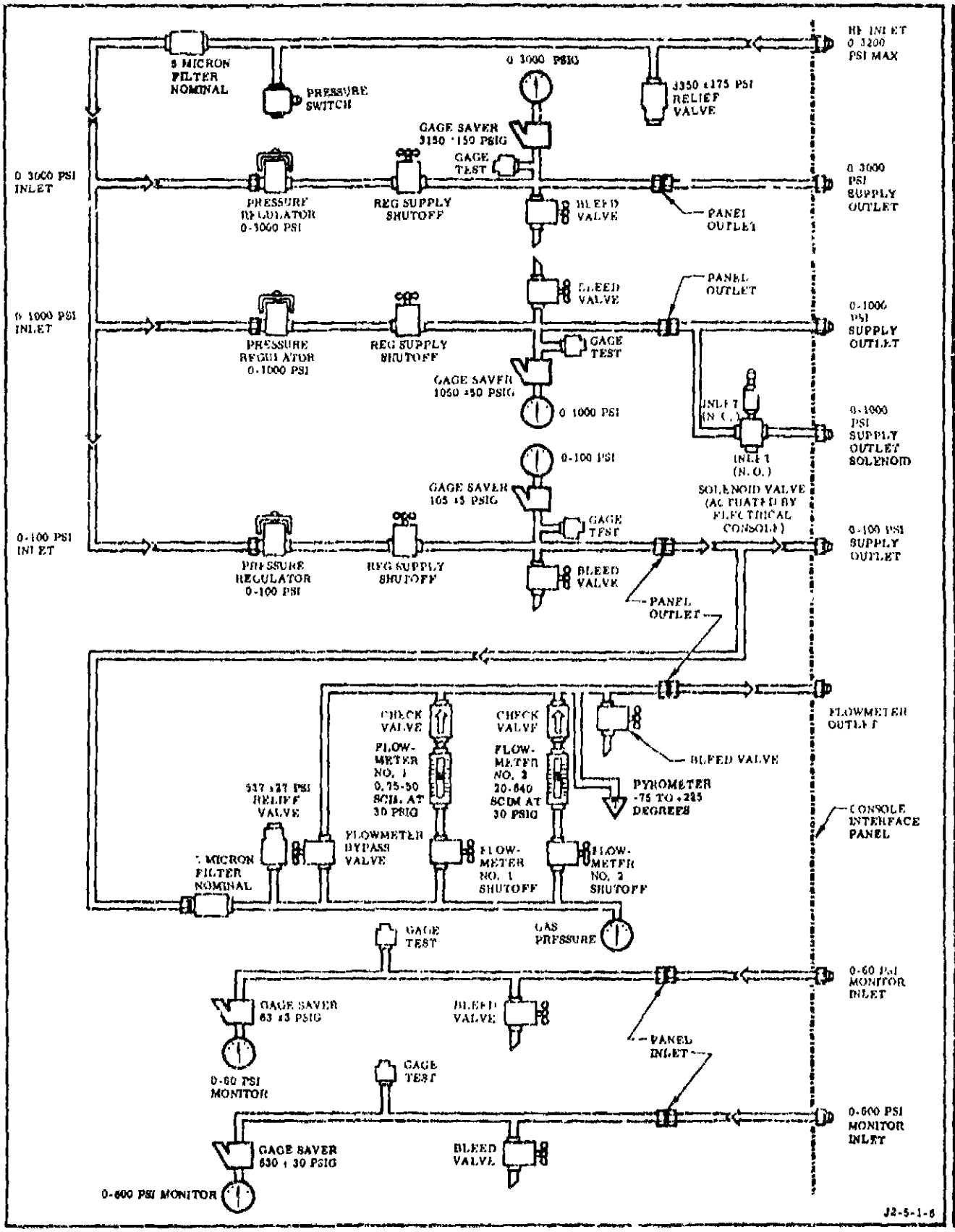

Figure 9-15. Pneumatic Schematic

9-21. CALIBRATION REQUIREMENTS.

9-22. Calibration checks to ensure gage and meter accuracy are performed on console gages, flowmeters, and temperature gage. The accuracy of the console instruments is verified by comparison with a known standard.

9-23. PRESSURE GAGE CHECK. See figure 9-16 for pressure gage calibration-check requirements. All gages listed in figure 9-16 are used in pneumatic systems.

Part Number	Nomenclature	Range/Accuracy (± Full Scale)	Test Standard[a] Minimum Accuracy (± Full Scale)
19-9017879-4	GAS PRESSURE	0-500 psig (2%)	0.8%
19-9019557-1	MONITOR INLET	0-60 psig (0.25%)	0.1%
19-9019557-2	REG SUPPLY PRESSURE	0-100 psig (0.25%)	0.1%
19-9019557-3	MONITOR INLET	0-600 psig (0.25%)	0.1%
19-9019557-4	REG SUPPLY PRESSURE	0-1000 psig (0.25%)	0.1%
19-9019557-5	REG SUPPLY PRESSURE	0-3000 psig (0.25%)	0.1%

(a) Range of test standard must be at least 100% but not more than 125% of range of instrument being tested.

Figure 9-16. Pressure Gage Calibration-Check Requirements

9-24. FLOWMETER CHECK. Check flowmeters with helium pressurized to 30 psig, supplied to the 0-100 PSI SUPPLY OUTLET on the interface panel. Helium must meet requirements specified in section I. The pressure test gage must have a range of 0-60 psig, with a minimum accuracy of ±0.5 percent. The flowmeter must be within 10 percent of full scale of the calibration curves supplied with the pneumatic console at 20, 40, 60, and 80 percent of full-scale reading for each float.

9-25. GAS TEMPERATURE GAGE AND THERMOCOUPLE CHECK. Remove and immerse thermocouple and a laboratory-type mercury thermometer in clean, distilled water and compare readings. Perform a three-point check at temperatures of 55° to 95° F. The gas temperature gage indicator must not differ from the laboratory thermometer indication by more than 8° F. The laboratory thermometer must have an accuracy of ±1° F over a range of 55° to 95° F. When removing the thermocouple or pyrometer, handle with care and do not allow either to be suspended on interconnecting wire leads.

CAUTION

The soldered connections and light gage wire leads can be damaged or broken from strain.

9-26. PREPARING FOR STORAGE.

9-27. Prepare console for storage or shipment as follows:

a. Ensure that all outlet ports on interface panel are capped.

b. Ensure that flexible hoses are properly capped.

c. Ensure that accessories (figure 9-8) are stored in proper containers.

d. Place accessories and flexible hoses in storage drawers.

e. Cover console with greaseproof barrier material (MIL-B-121, Grade A), or equivalent, and seal at bottom edge of cabinet.

Figure 9-17 deleted.

9-28. MAINTENANCE OF PNEUMATIC CONSOLE COMPONENTS.

9-29. Maintenance of components consist of adjusting gage savers, regulators, relief valves, and proof-testing flexible hoses. Leak- and function-test console after installation of component (paragraph 9-19).

9-30. REMOVING AND INSTALLING COMPONENTS.

9-31. No special instructions are required to remove or install components in pneumatic console, except replacing warning light bulb and torquing screws securing panels to 7-9 inch-pounds.

9-32. REPLACING WARNING LIGHT BULB.

9-33. Replacing warning light bulb consists of removing and installing dome and light bulb.

a. Remove dome from warning light by depressing dome slightly and rotating it counterclockwise (looking down on the dome) until studs in dome are clear of lamp support rods, then lifting off dome.

b. Remove defective bulb. For ease of bulb removal, remove the 2 top nuts securing lamp socket to support rods, and lift off socket.

CAUTION

Care must be taken not to damage the connecting electrical wires.

c. Install replacement bulb. Reassemble lamp socket and torque nuts securing lamp socket to support rods to 6-8 inch-pounds.

d. Ensure that nuts securing support rods to base are torqued to 6-8 inch-pounds.

e. Ensure security of electrical wiring to tie-rod supports of lamp socket. Wires must be taped securely to outboard surface (away from rotating lens) of tie-rods. If security of wiring is inadequate or marginal, use additional tape as required to effectively secure wiring and prevent its contact with lens assembly.

f. Ensure that a minimum 1/8-inch clearance exists between rotating lens assembly and support rods and/or electrical wiring.

g. Replace dome.

NOTE

When reinstalling dome, apply only that force necessary to position the studs under the lamp support rods. Excessive force will distort the lamp supports and adversely affect the clearance between the supports and the rotating lens assembly.

h. Disconnect plug P2 from connector J2 and install a jumper wire from P2-B to P2-C, to permit energizing warning light without pressurizing pneumatic console.

i. Energize warning light by applying positive (+) 28 vdc to pin J1-A and negative (-) 28 vdc to pin J1-C (figure 9-18).

j. Visually ensure that 1/8-inch clearance still exists between rotating lens assembly and support rods and/or electrical wiring.

k. Deenergize warning light, remove jumper wire from plug P2, and reconnect plug P2 to connector J2.

9-34. ADJUSTING GAGE SAVERS.

9-35. Adjust gage savers to values listed in column IV of figure 9-13 as follows:

a. Remove pneumatic pressure from gage saver to be tested.

b. Insert a 1/4-inch key wrench into screw inside of gage saver, turn key wrench clockwise to increase setting, or counterclockwise to decrease setting.

c. Pressurize gage saver to applicable pressure in column III (figure 9-13). Gage saver must indicate pressure in column IV. Record.

d. Depressurize gage saver and repeat step c three times. Difference between first and fourth shutoff pressures must not exceed pressure specified in column V.

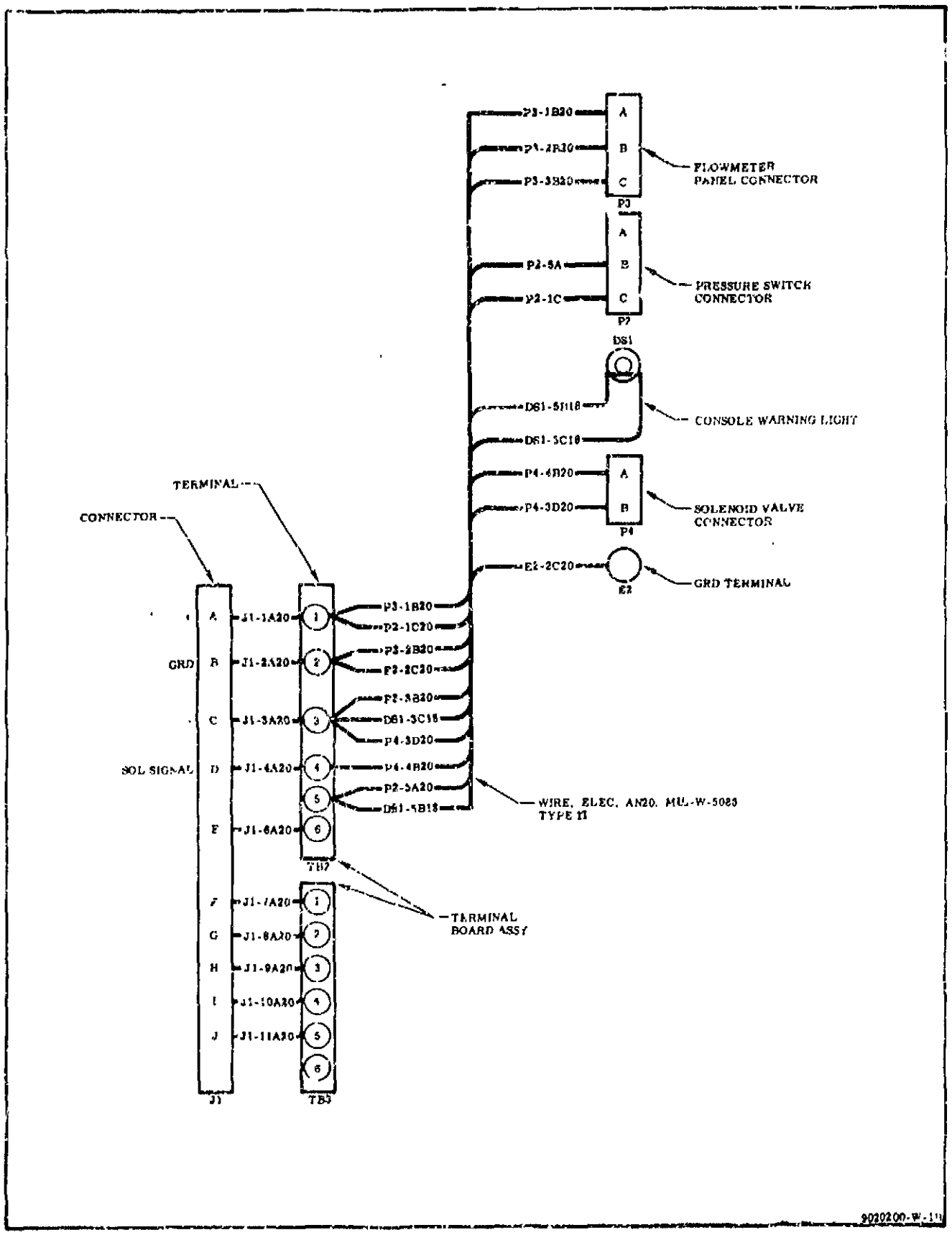

Figure 9-18. Console Wiring Diagram

9-36. ADJUSTING PRESSURE REGULATORS.

9-37. The bleed adjustment pressures for regulators are 700 ±50 psig for 0-3000, 150 ±30 psig for 0-1000, and 10 ±3 psig for 0-100. Adjust regulator as follows:

a. Insert a 3/32-inch key wrench through adjusting knob screw and adjust push rod.

NOTE

Turning key wrench clockwise decreases (counterclockwise increases) the number of turns required by the adjust knob for the regulator to start venting. This adjustment also stops the constant bleed.

b. If necessary, repeat step a until regulator is adjusted within required limits, then test regulator (paragraph 9-19).

9-38. ADJUSTING HIGH-PRESSURE RELIEF VALVE.

9-39. The high-pressure relief valve is adjusted by loosening locknut on adjusting screw, turning adjusting screw (clockwise to increase or counterclockwise to decrease pressure setting), and tighten locknut while holding adjusting screw. Repeat procedure if necessary until relief pressure setting of 3,350 ±175 psig and re-seating pressure of 2,990 psig are obtained.

9-40. ADJUSTING FLOWMETER PANEL RELIEF VALVE.

9-41. Adjust the relief valve by inserting an adjusting wrench into outlet of valve and turning adjustment screw (clockwise to increase or counterclockwise to decrease pressure setting). Test relief valve and repeat adjusting procedure if necessary to obtain pressure setting of 537 ±27 psig and re-seating pressure at 480 ±5 psig.

9-42. PROOF-PRESSURE-TESTING HOSES.

9-43. Proof-pressure-test flexible hoses 19-9019556-1 and 19-9019556-2 and allowable alternates (figure 9-8) hydrostatically or with gaseous nitrogen that meets requirements specified in section I. Hoses that are tested hydrostatically must be cleaned as noted in the procedure. Proof-pressure-test hoses as follows:

a. Apply the following pressure to flexible hose for 5 minutes:

(1) 8,000 ±160 psig to 1/4-inch diameter hoses 19-9019556-1 and allowable alternates

(2) 12,000 ±240 psig to 3/8-inch diameter hose 19-9019556-2 and allowable alternates

WARNING

Safety regulations must be observed when proof-pressure-testing. Proof-pressure can burst a hose, causing injury or death.

b. Remove pressure from flexible hoses. There must be no visual damage of hose assembly.

c. Clean flexible hoses (if tested hydrostatically). Refer to cleaning in section I.

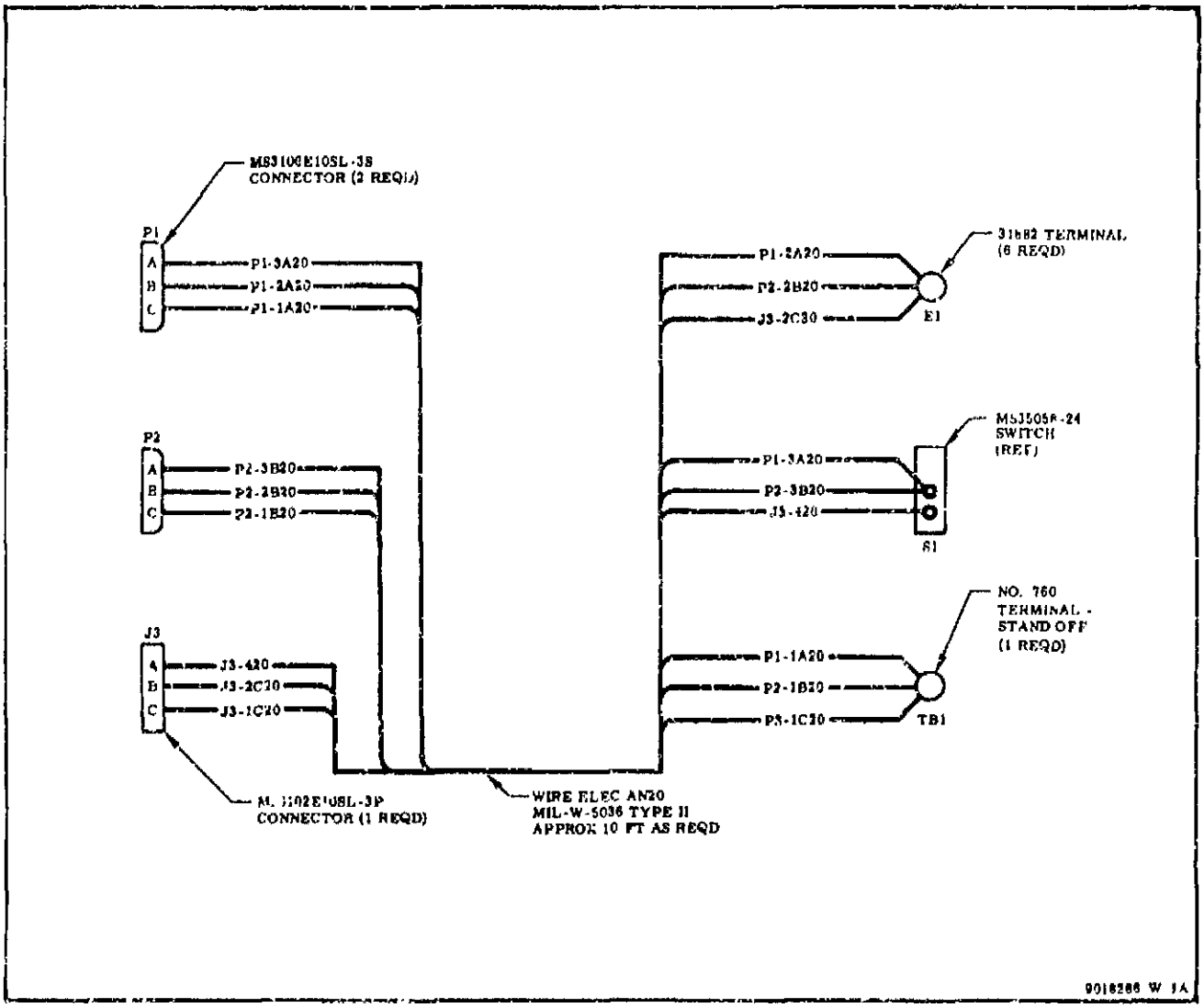

Figure 9-19. Flowmeter Panel Wiring Diagram

9-44. LEAK-TESTING FLEXIBLE HOSES.

9-45. Leak-test flexible hoses 19-9019556-1 and 19-9019556-2 and allowable alternates (figure 9-8) using helium that meets requirements specified in section I, as the pressurizing agent. (Testing may be accomplished by connecting a high-pressure flowmeter, if available, to inlet end of hose, immersing hose in water, or other suitable means. If hose is immersed in water, make sure container is large enough to avoid sharp bends in hose. Multiple leaks may be accumulated to a single point by encasing hose in a bag or covering it with tape.) Leak-test hoses as follows:

a. Apply 1,000 ±20 psig to flexible hose. Allow approximately 10 minutes for stabilization of gases that may be trapped in outer layers of hose. Total allowable effusion must not exceed 1,000 cc within 15 minutes.

b. Remove pressure from flexible hoses.

SECTION X

PNEUMATIC FLOW TESTER G3104

WARNING

PNEUMATIC FLOW TESTER G3104 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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10-1. DESCRIPTION AND LEADING PARTICULARS.

10-2. The pneumatic flow tester (figures 10-1 and 10-2) is a portable flowmeter used to detect and measure low-pressure gaseous nitrogen or helium leakages utilizing meters in five ranges. The tester consists of an instrument panel, leveling legs, and storage compartment for accessories incorporated in a two-piece carrying case. The instrument panel contains five flowmeters, a pyrometer, thermocouple, flow inlet and outlet, and a level. METER NO. 1 through METER NO. 3 each contain a sapphire ball float; METER NO. 4 contains a glass ball float; and METER NO. 5, a steel ball float. Adapters, a meter hose, a source hose, and a handle are stored in the compartment. An accumulator assembly, accumulator hose, adapter, and Y-adapter are included. The carrying case incorporates a liner surrounding the instrument panel to protect it from damage during transit. Leveling lugs on the carrying case are used for the attachment of the leveling legs stored in the recesses of the liner. A valve on the carrying case is used to stabilize internal case pressure with atmospheric pressure. Leading particulars for the flow tester are listed in figure 10-3.

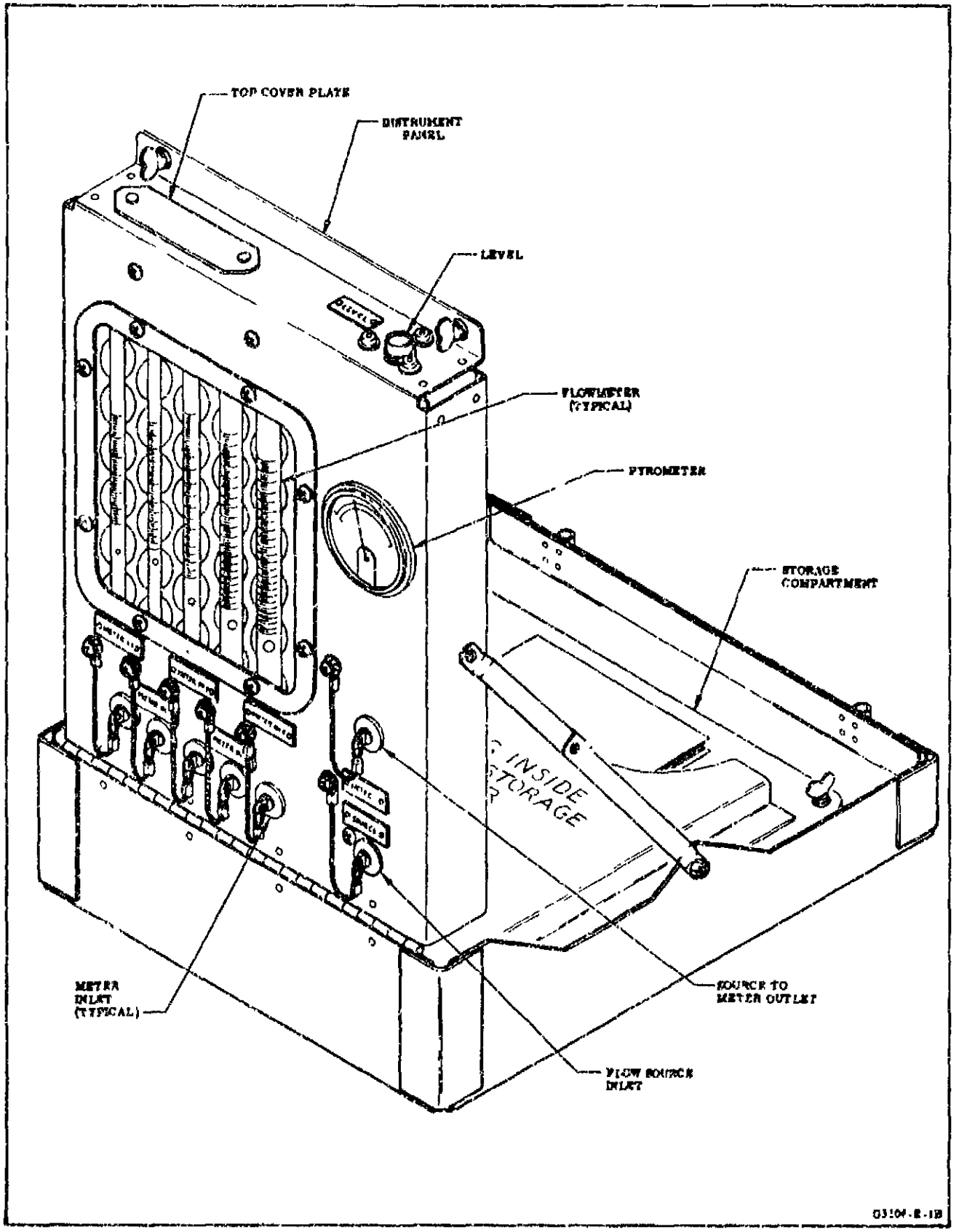

Figure 10-1. Pneumatic Flow Tester

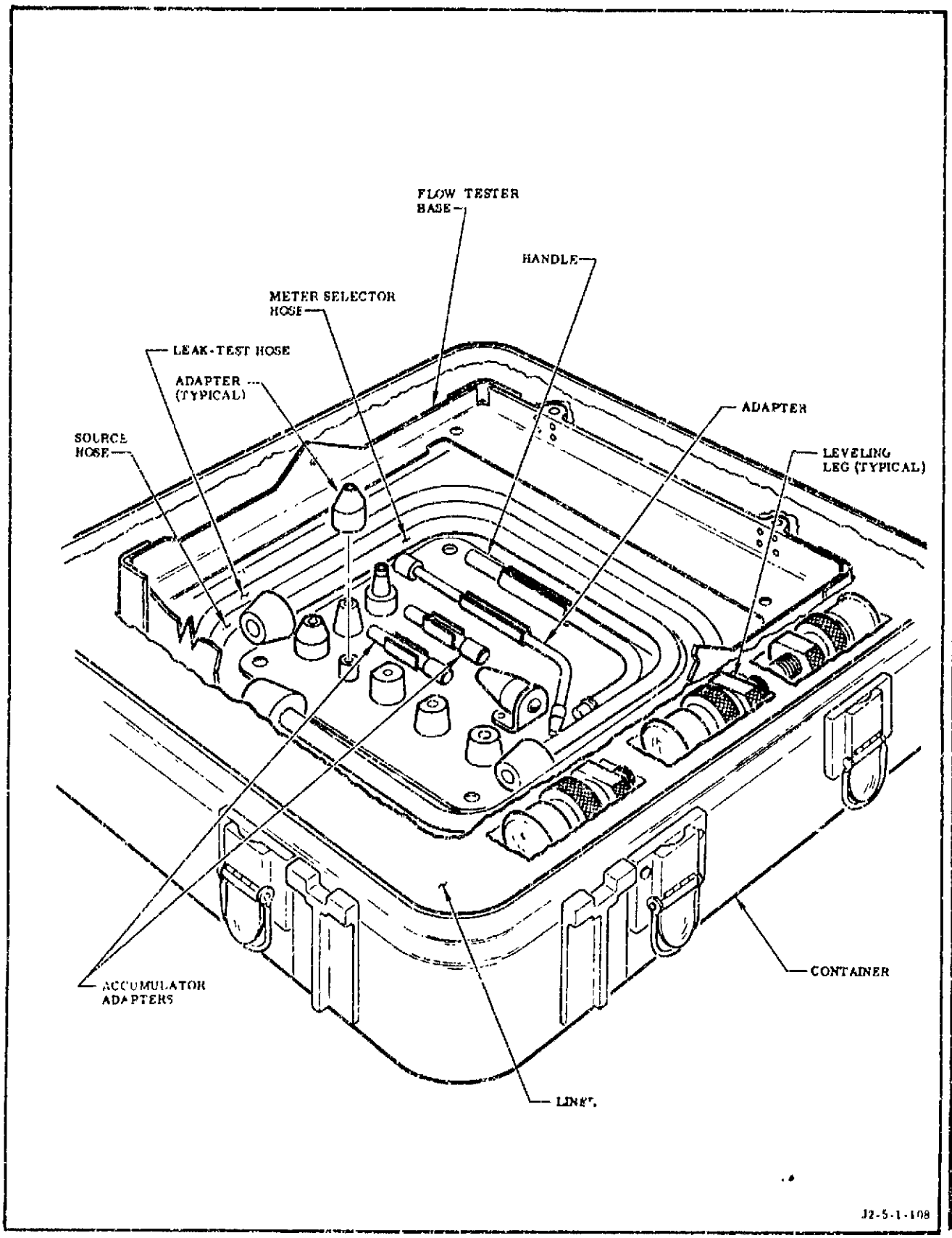

Figure 10-2. Accessory Storage

Dimensions		
Length	22.42 inches	
Width	19.25 inches	
Height	8.75 inches	
Weight	40 pounds	
Meter Capacities in scim (Nominal)		
	Nitrogen	Helium
No. 1	0.26 to 2.60	0.29 to 2.90
No. 2	1.1 to 11.3	1.5 to 15.5
No. 3	5.8 to 58.5	11.8 to 118.0
No. 4	55.5 to 555.0	100 to 1,340
No. 5	410 to 4,100	1,000 to 10,000
Pyrometer Range:		
Indicated	-75° to +225° F	
Usable	+40° to +125° F	

Figure 10-3. Leading Particulars

10-3. ACCESSORIES.

10-4. The accessories stored in the pneumatic flow tester consist of interconnecting hoses, handle, and adapters. Placarded mounting fittings are provided for the adapters and handle. Figure 10-4 lists the accessories.

Nomenclature	Part Number	Remarks
Adapter	908129	0.06-inch ID x 0.12-inch OD tip
Adapter	908130	0.19-inch ID x 0.56-inch OD tip
Adapter	908131	0.19-inch ID x 0.38-inch OD tip
Adapter	908132	Close-corner for a 0.12-inch diameter hole 0.09 inch from side
Adapter	908133	0.16-inch ID x 0.22-inch OD tip
Adapter	908138	Close-corner for a 0.25-inch diameter hole 0.19 inch from side
Adapter	908139	Close-corner for a 0.38-inch diameter hole 0.42 inch from side
Adapter	908141	0.38-inch ID x 0.90-inch OD tip
Meter Hose	907041	3/8-inch ID x 1/2-inch OD x 20 inches
Handle	907042	Connects source nose to adapters
Source Hose	907043	3/8-inch ID x 1/2-inch OD x 96 inches
Adapter (Naflex seal vent)	9022319	1/8-inch diameter x 0.060-inch diameter tip
Adapters (Accumulator)	9022320	0.375-inch OD x 0.437-inch OD x 3 ±0.06 inches (2 required)
Hose (Accumulator)	9022321	3/8-inch ID x 1/2-inch OD x 96 ±1 inches
Accumulator Assembly	9024714	
Bag	9024714-3	12 x 18 inches
Accumulator	9022322	23 x 24 inches
Adapter Y-Fitting	69196	3/8-inch OD

Figure 10-4. Accessories

10-5. THEORY OF OPERATION.

10-6. The pneumatic flow tester is connected downstream of the system or component under test. The pneumatic flow enters the panel SOURCE inlet, flows from the panel METER outlet, passes through the meter hose into the flowmeter, and vents to atmosphere. Temperature of the pneumatic flow is indicated on the pyrometer. Leakage in the system or component under test is indicated on the applicable flowmeter. Flow curves developed by the user and a temperature correction chart provided in this section enable the user to convert flow and temperature indications to scim leakage rates.

10-7. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

10-8. The modifications incorporated changing the configuration of the pneumatic flow tester are listed in figure 10-5.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-221	1	26 January 1965

Figure 10-5. Configuration Changes--Manual Effectivity

10-9. USING PNEUMATIC FLOW TESTER.

10-10. The pneumatic flow tester is used to measure gaseous nitrogen or helium flow downstream of a system or component and cannot be used to measure flow under pressure. Using the tester consists of preparing tester for use, measuring flow, and using individual meter flow curves and a temperature correction chart to convert meter scale readings to flow in standard cubic inches per minute (scim).

10-11. PREPARING FOR USE.

10-12. When using the tester in drafty conditions, the instrument panel must be faced into the draft since meters are affected by pressure on the back of the panel.

a. Open relief valve on side of case. Unlatch and remove top of case.

b. Remove 3 leveling legs from case and attach to bottom of case.

c. Lift hinged instrument panel and lock in vertical position.

d. Position tester to permit connection of source hose to component or system being tested.

e. Adjust leveling legs on bottom of case until bubble level on instrument panel indicates tester is in level position.

10-13. MEASURING FLOW.

10-14. The expected flowrate of the system or component to be tested should be determined and a meter with sufficient capacity used. Figure 10-3 lists meter capacities. When possible, a meter that will indicate in upper 2/3 of scale, to increase accuracy of result must be used. When flowrate is unknown, the largest capacity meter must be used and then the smallest capacity meter on which a reading can be obtained. Figure 10-6 illustrates a typical flow tester connection.

a. Verify that accuracy of applicable meter(s) has been checked within the previous 6 months, and is within the tolerance specified for the particular meter. Refer to paragraph 10-20.

b. Verify that the particular flow curve (nitrogen or helium) for applicable meter(s) is identified with the respective serial number, or equivalent, of the pneumatic flow tester being used.

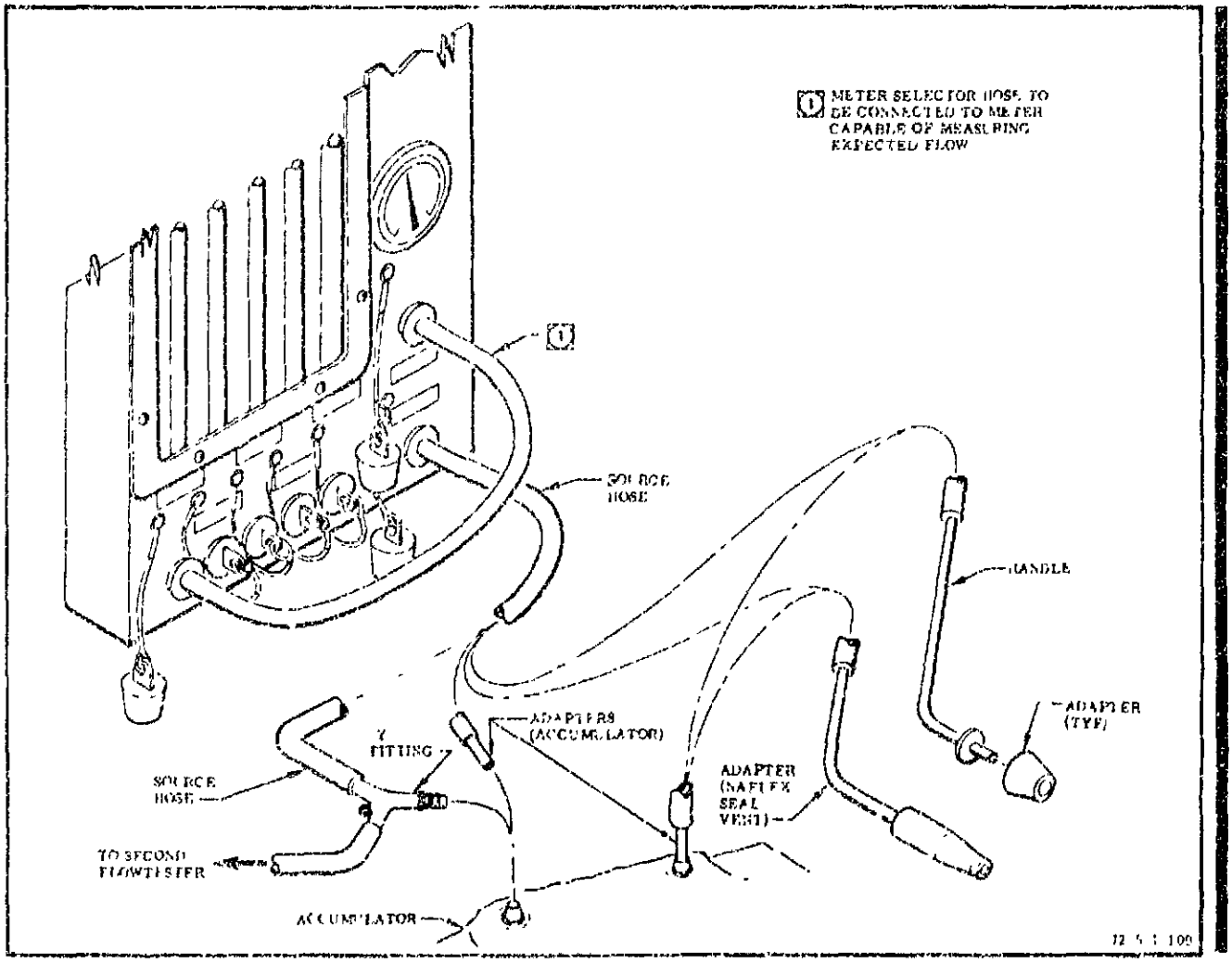

Figure 10-6. Pneumatic Flow Tester Setup

CAUTION

In the following steps, excessive flow surges must be anticipated and avoided, since damage to the float or float stop can occur.

c. Connect suitable hoses, adapters, and handle for flow-test to be performed. Connect meter hose to meter capable of measuring expected flow. The accumulator may be used to dampen flow surges. The accumulator must always be connected when METER NO. 5 is being used, to dampen oscillations that can cause damage to float or float stop. A second flow tester may be used to measure flow-rates beyond the capacity of a single flow tester.

d. Press and aline adapter onto part of system or component being tested. Make sure source hose is not kinked, adapter is alined with port, and there are no leaks in connections or flow tester equipment.

NOTE

Gas will not flow freely into source hose if adapter is not alined with port.

- Flowmeter reading will fluctuate if source hose is kinked or disturbed.

e. Observe and record temperature when flow has stabilized.

f. Observe and record flowmeter reading. Read indication at widest part of float.

NOTE

Scales on each flowmeter are arbitrary and bear no relation to each other. For example, a reading of 8 on METER NO. 1 scale has no relation to a reading of 8 on METER NO. 2 scale.

g. Using flow curve (scale reading versus actual flow), step b, for applicable meter, determine flow in scim. If temperature is different from that recorded on flow curve, apply flow reading obtained from flow curve to temperature correction chart (figure 10-7). Multiply actual flow reading by correction factor to obtain scim. Result obtained will be within the following tolerance for the respective meter:

METER NO. 1	10% of Full Scale
METER NO. 2	5% of Full Scale
METER NO. 3	5% of Full Scale
METER NO. 4	3% of Full Scale
METER NO. 5	3% of Full Scale

Flowmeter Temperature °F	Correction Factor When Standard Temp. 70° F	Flowmeter Temperature °F	Correction Factor When Standard Temp. 70° F
40	1.030	85	0.986
45	1.024	90	0.982
50	1.019	95	0.977
55	1.014	100	0.973
60	1.010	105	0.968
65	1.005	110	0.964
70	1.000	115	0.960
75	0.995	120	0.956
80	0.991	125	0.952

Figure 10-7. Temperature Correction Chart

10-15. MAINTENANCE OF PNEUMATIC FLOW TESTER.

10-16. Maintenance tasks required on the pneumatic flow tester are listed in figure 10-8. Information presented lists the tasks to be performed, when the tasks must be performed, and reference to data necessary to accomplish the tasks.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect tester for completeness.	X	X			See figures 10-1 and 10-2. Refer to paragraph 10-3.
Inspect meters and tubes for condensation.	X	X			Clean meter tube. Refer to paragraph 10-28.
Broken, chipped, or damaged floats.	X	X			Clean meter tube and replace float. Refer to paragraphs 10-28 and 10-29.
Foreign matter and cleanness.		X			Clean meter tube. Refer to paragraph 10-28.

Figure 10-8. Maintenance Requirements (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Leak- and function-test tester.				X	Every 6 months, when malfunction is suspected, when accuracy of meters must be verified, and subsequent to cleaning meters. Refer to paragraph 10-18.
Leak-test accumulator				X	Every 6 months or when malfunction is suspected. Refer to paragraph 10-18A.
Clean tester carrying case and instrument panel exterior.				X	Clean. Refer to Cleaning in section I.
Clean tester adapters, hoses, and handle.				X	When contaminated. Refer to paragraph 10-27.
Clean tester meters.				X	When meter fails leak- and function-test or operates erratically. Refer to paragraph 10-28.
Develop flow curve.				X	Prior to initial use. Any time meter fails to come within specified tolerance (paragraph 10-20) during subsequent accuracy verification checks. Refer to paragraph 10-22.
Clean exhaust manifold screen.				X	When contaminated. Refer to Cleaning in section I.
Paint instrument panel.				X	When surface is damaged. Paint with grey semi-gloss enamel (TT-E-529); color 26622 (Federal Standard 595).
Paint case exterior.				X	When surface is damaged. Paint with green camouflage enamel (Federal Specification TT-E-527); color 34300 (Federal Standard 595).
Prepare tester for storage.				X	When not in use. Refer to paragraph 10-24.

Figure 10-8. Maintenance Requirements (Sheet 2 of 2)

10-17. LEAK- AND FUNCTION-TESTING.

10-18. The leak- and function-test consists of a pyrometer check and a leak-test of the flow system.

a. Prepare tester for use (paragraph 10-12).

b. Obtain test equipment (figure 10-9).

c. Remove instrument panel rear cover and top cover plate.

d. Remove thermocouple from temperature manifold.

e. Check pyrometer and thermocouple by immersing thermocouple in clean distilled water with thermometer. Perform test at 3 temperatures between 55° and 95° F. Pyrometer must indicate within 8° F of thermometer indication.

Nomenclature	Accuracy	Use
Regulated pressure source of gaseous nitrogen or helium, consisting of a pressure regulator, pressure gage, and a needle valve.		To control and monitor flowmeter inlet pressures of 1.5 to 2.3 in. H_2O for leak-check and 0.5 to 14.0 in. H_2O for function, accuracy verification, and calibration checks.
Piezometer (3/8-inch)		To use with manometer when measuring back pressure created by flow tester.
Water Manometer(a)		To measure low-pressure.
Flow Calibration Standard	1.0% of indicated reading	To compare readings with meters.
Mercury Thermometer, Range of 40° to 100° F	±1° F	To measure accuracy of pyrometer and thermocouple.

(a) Water manometer must be a minimum of 30 inches or of sufficient capacity to measure back pressure created by flow calibration standard.

Figure 10-9. Test Equipment

f. Install thermocouple in temperature manifold.

g. Install short lengths of plastic hose, or equivalent, of applicable sizes to outlet of each meter tube and plug end of hoses. See figure 10-10 for meter and hose sizes.

h. Connect meter hose between **METER** port and **METER NO. 1** port.

i. Connect source hose between SOURCE port on instrument panel and regulated supply source of gaseous nitrogen (MIL-P-27401) or helium (MIL-P-27407, or Bureau of Mines, Grade A) (refer to section I).

j. Apply 0.5 to 1.0 psig pneumatic pressure to **METER NO. 1.**

NOTE

It may be necessary to hold the plug installed at the end of the plastic hose during pressurizing and leak-test, to prevent it from blowing out.

k. Apply leak-test compound (MSFC-SPEC-384) to meter tube, inlet manifold, and thermocouple connections. No leakage is allowable.

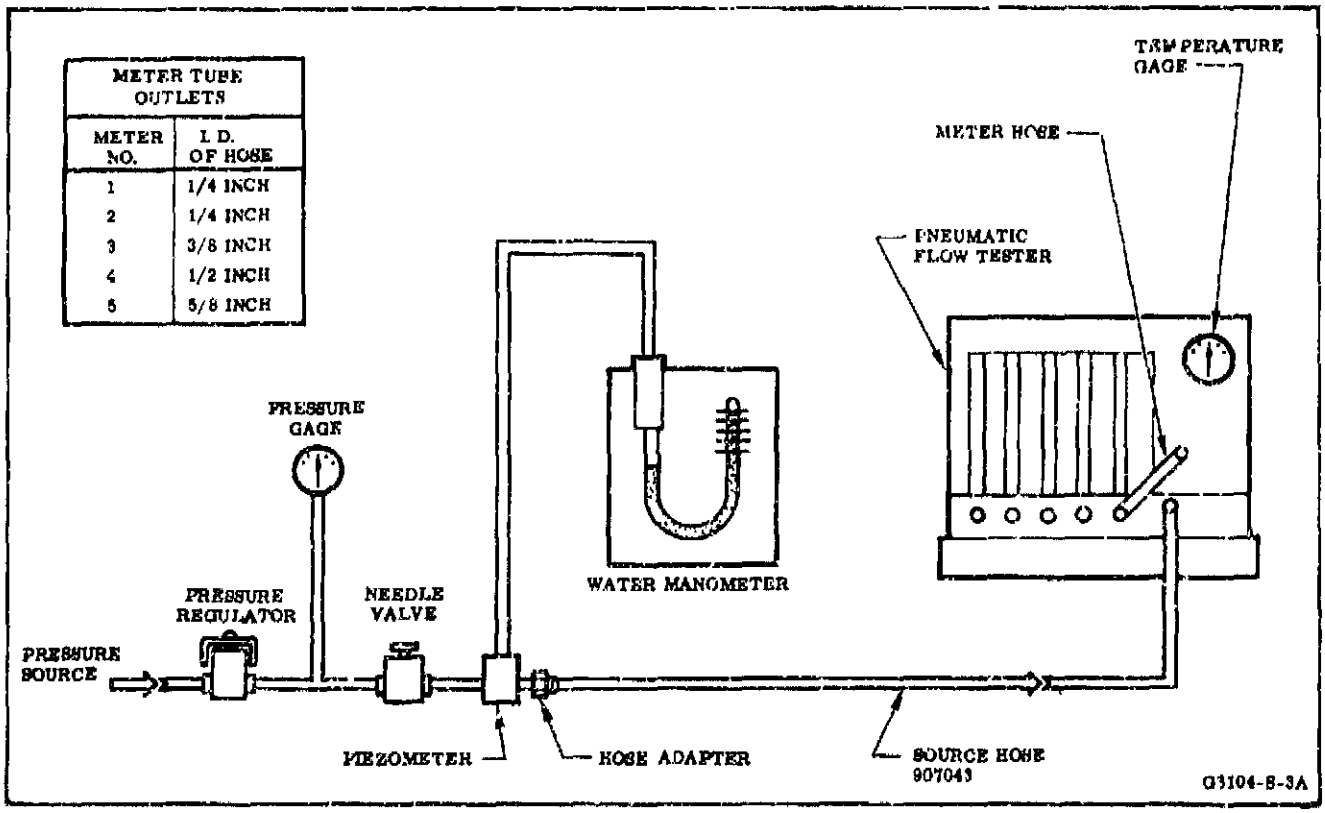

Figure 10-10. Function-Test Setup

l. Remove pressure flow from METER NO. 1.

m. Remove meter selector hose from METER NO. 1 port and install it in METER NO. 2 port. Cap METER NO. 1 port.

n. Repeat steps h through m to leak-test METER NO. 2 through METER NO. 5, applying leak-test compound only to meter tube connections.

o. Leak-test accumulator bag by pressurizing with gaseous nitrogen (MIL-P-27401) to 13 inches of water (approximately 0.4691 psig), sealing both ports, and immersing in water. No leakage is allowable.

p. Remove plastic hoses from meter tubes.

q. Connect flow tester into test setup shown in figure 10-10. Needle valve and all test equipment between needle valve and source hose must have a minimum diameter of 3/8-inch.

r. Make sure that needle valve is closed; then adjust regulator to 4-6 psig.

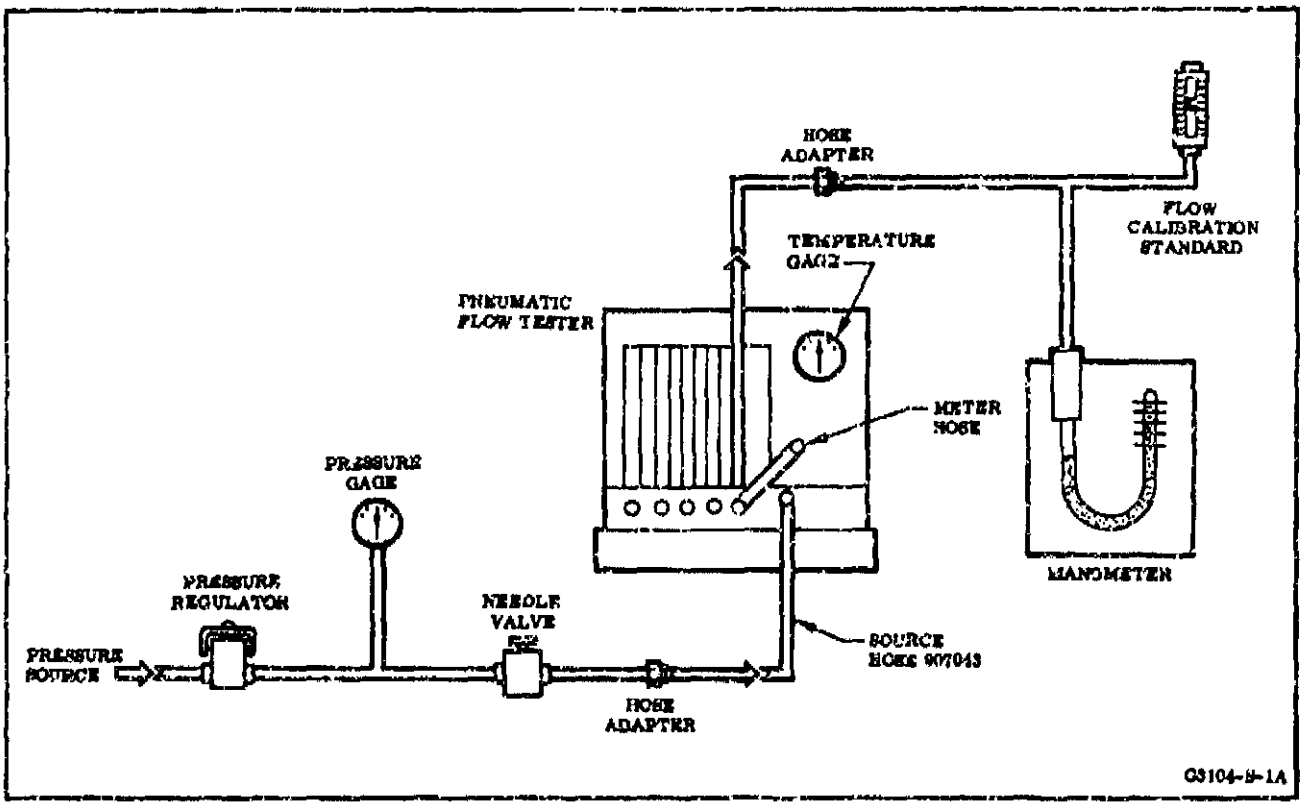

Figure 10-11. Accuracy-Test Setup

s. Apply a flowrate equivalent to maximum capacity of METER NO. 1, using needle valve to adjust flow, and observe manometer indication. Manometer must not exceed 0.5 inch. If manometer readings are excessive, clean meter (paragraph 10-28) before proceeding with test.

t. Remove meter hose from METER NO. 1 and repeat step s for METER NO. 2 through METER NO. 5, connecting hose to applicable meter. Manometer indication must not exceed the following indications:

(1) Meter No. 2: 0.5 inch.

(2) Meter No. 3: 0.7 inch.

(3) Meter No. 4: 1.0 inch.

(4) Meter No. 5: 14.0 inches.

u. Decrease pressure to zero.

v. Disconnect and secure test equipment.

w. Install rear cover and top cover plate on instrument panel. Torque screws to 12-14 inch-pounds.

x. Place handle, adapters, and hoses in tester storage compartment. See figure 10-2.

y. Unlock braces and place instrument panel in case. Install case cover and secure locks.

10-18A. LEAK-TESTING ACCUMULATOR. Leak-test accumulator and accumulator hose and adapters as follows:

a. Connect hoses and adapters to accumulator to provide a pressure source and to connect a water manometer. (Connect water manometer to adapter on accumulator opposite pressure inlet.)

b. Pressurize accumulator to 10 ±1 inches of water.

c. Immerse pressurized accumulator (and adapters) in water and check for leakage along seams on all 4 edges and at connectors on accumulator. No leakage is allowable. (It is not necessary to submerge entire accumulator at one time.)

d. Check for surface leakage (both sides). (Surfaces may be checked by carefully running water over one area at a time.) No leakage is allowable.

10-19. ACCURACY VERIFICATION CHECK.

10-20. The accuracy verification check consists of obtaining comparison readings of each flowmeter tube with a laboratory standard having an accuracy of 1.0 percent of indicated reading.

a. Connect flow tester into a test setup similar to, and which performs the same function as, the test setup shown in figure 10-11. Needle valve and all test equipment between needle valve and source hose must have a minimum inside diameter of 3/8-inch. All test equipment between flow tester and flow calibration standard must be same size as meter tube being tested. Figure 10-10 lists meter tube sizes.

b. Establish a flowrate equivalent to approximately each 10 percent increment of full scale on METER NO. 1. Record the following data for each flow:

(1) Gas temperature and scale reading on pneumatic flow tester (allowing for temperature stabilization).

(2) Absolute pressure at flowmeter outlet.

(3) Actual flow in scim at 14.7 psia and 70° F.

c. Determine indicated flow (in scim) using flow curve (scale reading versus actual flow) for each flowrate through each meter. Refer to paragraph 10-14.

d. Multiply each result obtained in step c by temperature correction factor obtained from figure 10-7.

e. Correct result obtained in step d for flowmeter condition of average barometric pressure indicated on calibration curve being verified.

f. Indicated flows obtained in step e must be within 3 percent of full scale of respective flows obtained in step b, substep 3.

g. If results of step f are not obtained, clean meter (paragraph 10-28) and repeat procedure. If meter is still not within tolerance (step f), terminate procedure and develop new flow curves (paragraph 10-22).

h. Reduce pressure to zero.

i. Remove meter hose from METER NO. 1 and repeat steps a through h for METER NO. 2 through METER NO. 5, connecting meter hose to applicable meter.

j. Disconnect and secure test equipment.

k. Install rear cover and top cover plate on instrument panel. Torque screws to 12-14 inch-pounds.

l. Place handle, adapters, and hoses in tester storage compartment. See figure 10-2.

m. Unlock braces and place instrument panel in case. Install case cover and secure locks.

10-21. DEVELOPING FLOW CURVE.

10-22. Develop a flow curve for each meter any time an out-of-tolerance condition exists. See figure 10-12 for a typical flow plot. A flow curve (scale reading versus flow in scim) is required for each meter prior to obtaining flow measurements.

a. Obtain test equipment (figure 10-9).

b. Install pneumatic flow tester in a test setup similar to, and which performs the same function as, test setup shown in figure 10-11. Needle valve and all test equipment between needle valve and source hose must have a minimum inside diameter of 3/8-inch. All test equipment between flow tester and flow calibration standard must be same size as meter tube being tested. Figure 10-10 lists meter tube outlet sizes.

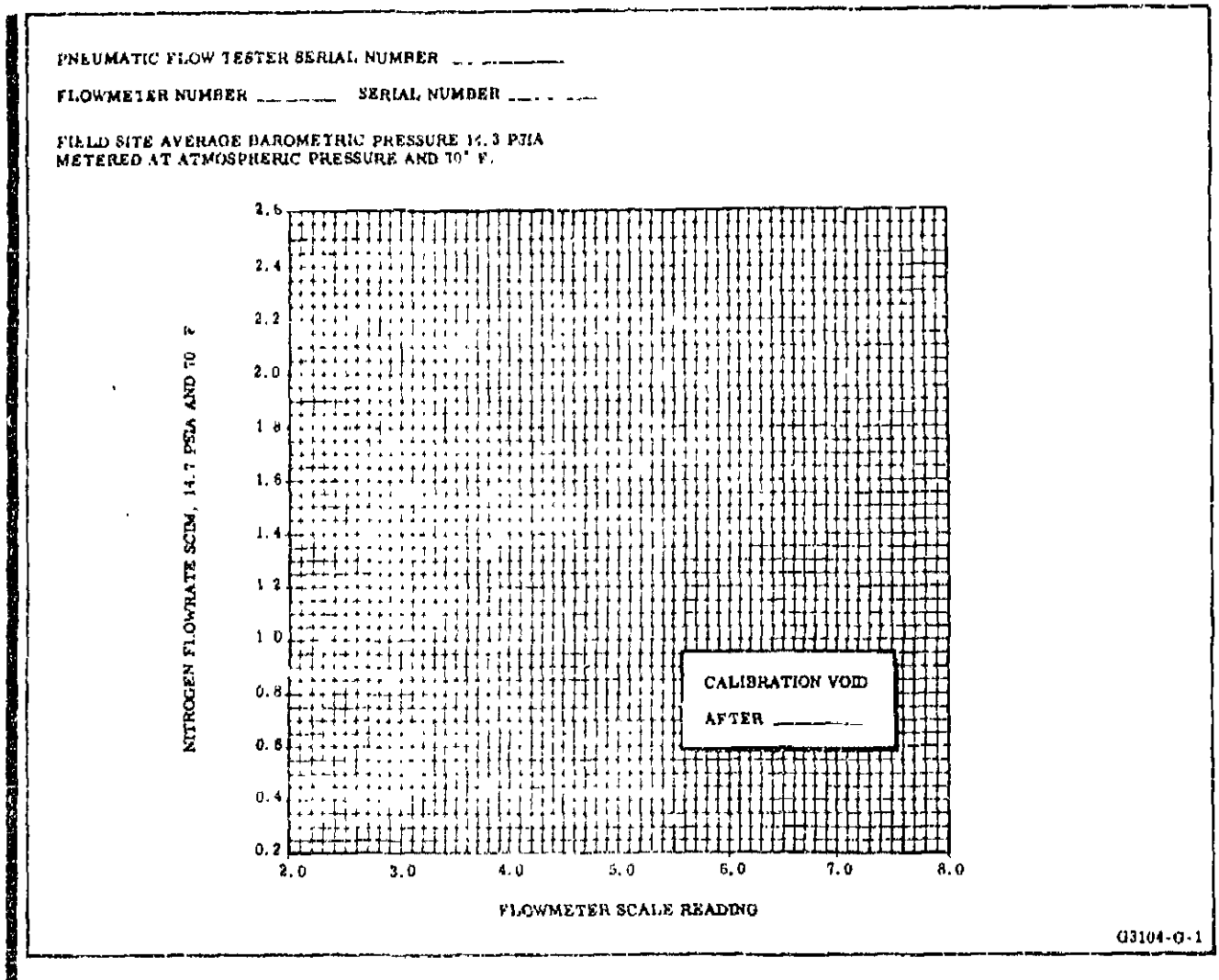

Figure 10-12. Typical Flow Plot

c. Establish a flowrate equivalent to approximately each 10 percent increment of full scale on METER NO. 1. Record the following data for each flow:

(1) Gas temperature and scale reading on pneumatic flow tester (allowing for temperature stabilization).

(2) Absolute pressure at flowmeter outlet.

(3) Actual flow in scim at 14.7 psia and 70° F.

d. Determine actual flow from step c, substep 3, corrected for a flowmeter condition of 70° F and the average barometric pressure at the particular site, using standard laboratory calibration procedures.

e. Plot a curve of scale reading and results of step d. See figure 10-12 for typical flow plot.

f. Remove meter hose from METER NO. 1, and repeat steps b through e for METER NO. 2 through METER NO. 5, connecting meter hose to applicable meter.

g. Reduce pressure to zero.

h. Disconnect and secure test equipment.

i. Install rear cover and top cover plate on instrument panel. Torque screws to 12-14 inch-pounds.

j. Place handle, adapters, and hoses in tester storage compartment. See figure 10-2.

k. Unlock braces and place instrument panel in case. Install case cover and secure locks.

10-23. PREPARING FOR STORAGE.

10-24. Prepare tester for storage as follows:

a. Make sure adapter, hoses, and handle are properly stored in tester compartment. See figures 10-2 and 10-4.

b. Remove leveling legs from exterior of case and store in liner.

c. Make sure instrument panel METER and SOURCE plugs are installed.

d. Lower instrument panel into case and secure in place.

e. Place cover on case and secure locks.

10-25. MAINTENANCE OF PNEUMATIC FLOW TESTER COMPONENTS.

10-26. Maintenance of components consists of cleaning, removing, installing, and antistatic-treating of meters.

10-27. CLEANING HOSES AND ADAPTERS. Remove contamination from source hose, meter hose, handle, and adapters by washing in a solution of mild alkaline cleaner RB0210-005 (Rocketdyne), or equivalent, per gallon of water at a temperature of 120° to 180° F. Rinse hoses, handle, and adapters with clean water, and dry thoroughly with low-pressure (10 psig maximum) gaseous nitrogen (MIL-P-27401). Clean accumulator hose and Y-adapter using same procedure.

10-28. CLEANING METERS. Cleaning the meters is accomplished on one meter at a time, with meter in place on tester.

a. Lift instrument panel and lock in upright position.

b. Remove instrument panel rear cover and top cover plate.

c. Install a 6-inch piece of Tygon (U. S. Stoneware Co) tubing, or equivalent, over outlet end of METER NO. 1. See figure 10-10 for inside diameter of tubing required for each meter.

d. Fill a clean, bent-tip oiler with trichloroethylene RB0210-003 (Rocketdyne). Oiler tip must be small enough to fit inlet manifold nipple. See figure 10-13.

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or loss of life.

e. Place flow tester on workbench in inverted position (figure 10-13).

f. Hold tubing (installed in step c) closed and fill with trichloroethylene from oiler.

g. Open tubing and allow trichloroethylene to drain.

CAUTION

Avoid spilling trichloroethylene on inlet manifold as damage to the manifold can result.

h. Repeat steps f and g a minimum of 3 times.

i. Purge inlet manifold with low-pressure (5 psig maximum) gaseous nitrogen (MIL-P-27401).

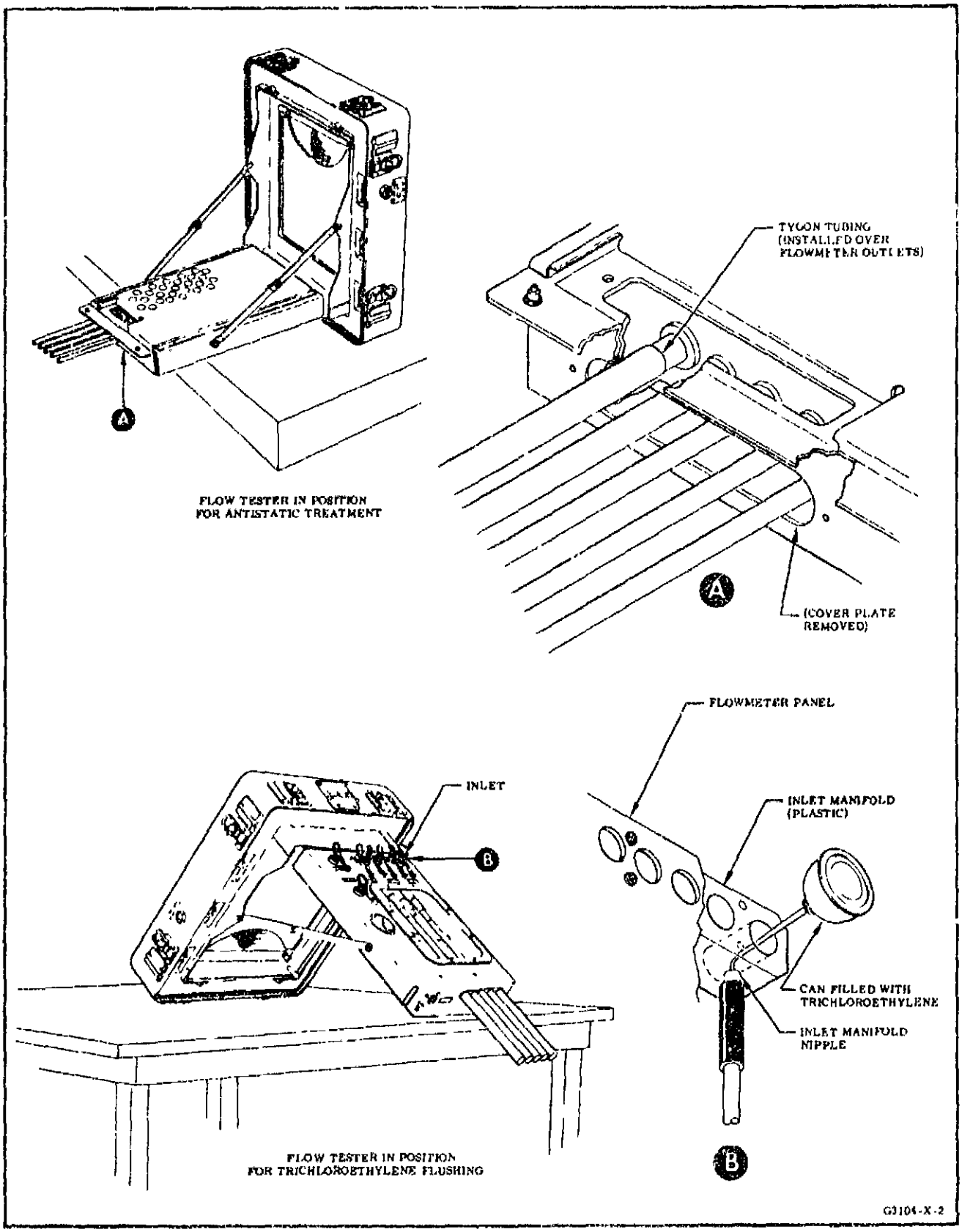

Figure 10-13. Cleaning Meters

j. Insert low-pressure gaseous nitrogen hose adapter into inlet manifold nipple and purge meter for approximately 3 minutes or until dry with low-pressure (5 psig maximum) gaseous nitrogen (MIL-P-27401).

CAUTION

Purge pressures exceeding five psig can cause damage to meters.

k. Treat METER NO. 1 with antistatic solution (paragraph 10-29).

l. Repeat steps c through k for METER NO. 2 and METER NO. 3, and steps c through j for METER NO. 4 and METER NO. 5.

m. Function-test tester. Refer to paragraph 10-18.

10-20. ANTISTATIC-TREATING METERS. METER NO. 1, METER NO. 2, and METER NO. 3 must be treated with antistatic solution subsequent to cleaning.

a. Set flow tester on bench in upright position.

b. Remove Tygon (U. S. Stoneware Co) tubing, installed during cleaning procedure, from meter outlet.

c. Fabricate an extractor hook. See figure 10-14.

d. Install extractor hook in hole in float stop and remove float stop from meter tube. See figure 10-14.

e. Install Tygon (U. S. Stoneware Co) tubing over meter outlet.

f. Place a piece of lint-free paper in palm of one hand to form a pocket for ball float.

NOTE

Float must be recleaned if touched by personnel.

g. Tilt meter slowly until ball float rolls out. Handle float with care.

CAUTION

Meter floats are easily damaged or broken.

h. Set paper and ball float on bench and place tester in antistatic-treatment position as shown in figure 10-13.

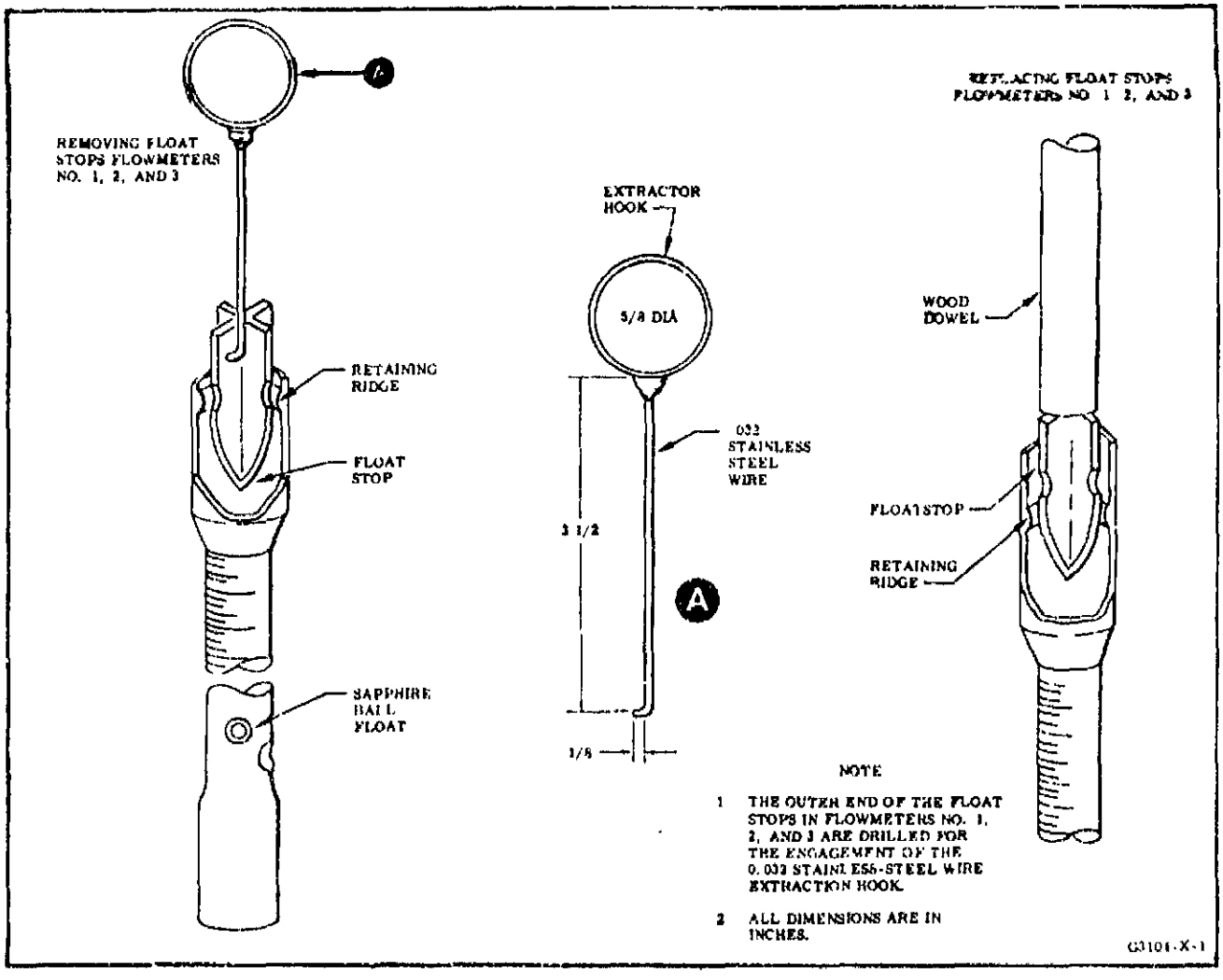
REMOVING FLOAT STOPS FLOWMETERS NO. 1, 2, AND 3
RETAINING RIDGE
FLOAT STOP
SAPPHIRE BALL FLOAT
EXTRACTOR HOOK
5/8 DIA
.032 STAINLESS STEEL WIRE
3 1/2
1/8
A
REPLACING FLOAT STOPS FLOWMETERS NO 1 2, AND 3
WOOD DOWEL
FLOAT STOP
RETAINING RIDGE
NOTE
1 THE OUTER END OF THE FLOAT STOPS IN FLOWMETERS NO. 1, 2, AND 3 ARE DRILLED FOR THE ENGAGEMENT OF THE 0.032 STAINLESS-STEEL WIRE EXTRACTION HOOK.
2 ALL DIMENSIONS ARE IN INCHES.
G3101-X-1

Figure 10-14. Removing and Installing Float Stop

i. Place a drop of ANSTAC-2M solution (Chemical Development Corp) on paper and roll ball float through solution until thoroughly coated.

j. Roll ball float over dry portion of paper until ball appears dry.

k. Place ball float into plastic tubing. Tilt tubing and tester so that ball float gently rolls into meter.

l. Place tester in upright position.

m. Wrap meter tube with a cloth; then install float stop. Make sure float stop engages meter tube retaining ridge. A wood or plastic dowel may be used to install float stop.

WARNING

The meter tube must be wrapped before installing float stop since breakage can cause serious injury to personnel.

n. Purge meter for 3 minutes with low-pressure (5 psig maximum) gaseous nitrogen (MIL-P-27401).

CAUTION

Purge pressures exceeding five psig can damage meters.

o. Apply a regulated flow (5 psig maximum) of gaseous nitrogen (MIL-P-27401) through a metering valve to meter inlet. Vary flow so float moves from bottom to top of scale. Make sure float moves freely. If float does not move freely, reclean meter.

NOTE

Increased duration of purge and decreased amounts of antistatic solution may eliminate float restriction.

10-30. REMOVING METER TUBES. To remove meter tubes, remove shield, plate, screen, exhaust manifold, and grommets from instrument panel. See figure 10-15. Cut and remove coupling sleeve from base of tube; then remove meter tube.

10-31. INSTALLING METER TUBES. An antistatic treatment must be performed on METER NO. 1, METER NO. 2, and METER NO. 3 tubes. Refer to paragraph 10-29.

a. Clean adhesive from inlet manifold with trichloroethylene (MIL-T-27602).

WARNING

Trichloroethylene is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Apply thin coat of general purpose adhesive (MIL-A-5092) approximately 3/4-inch wide around exterior of flowmeter tube and inlet manifold nipple, approximately 1/2-inch from end of tube and nipple. Do not allow adhesive to enter meter tube.

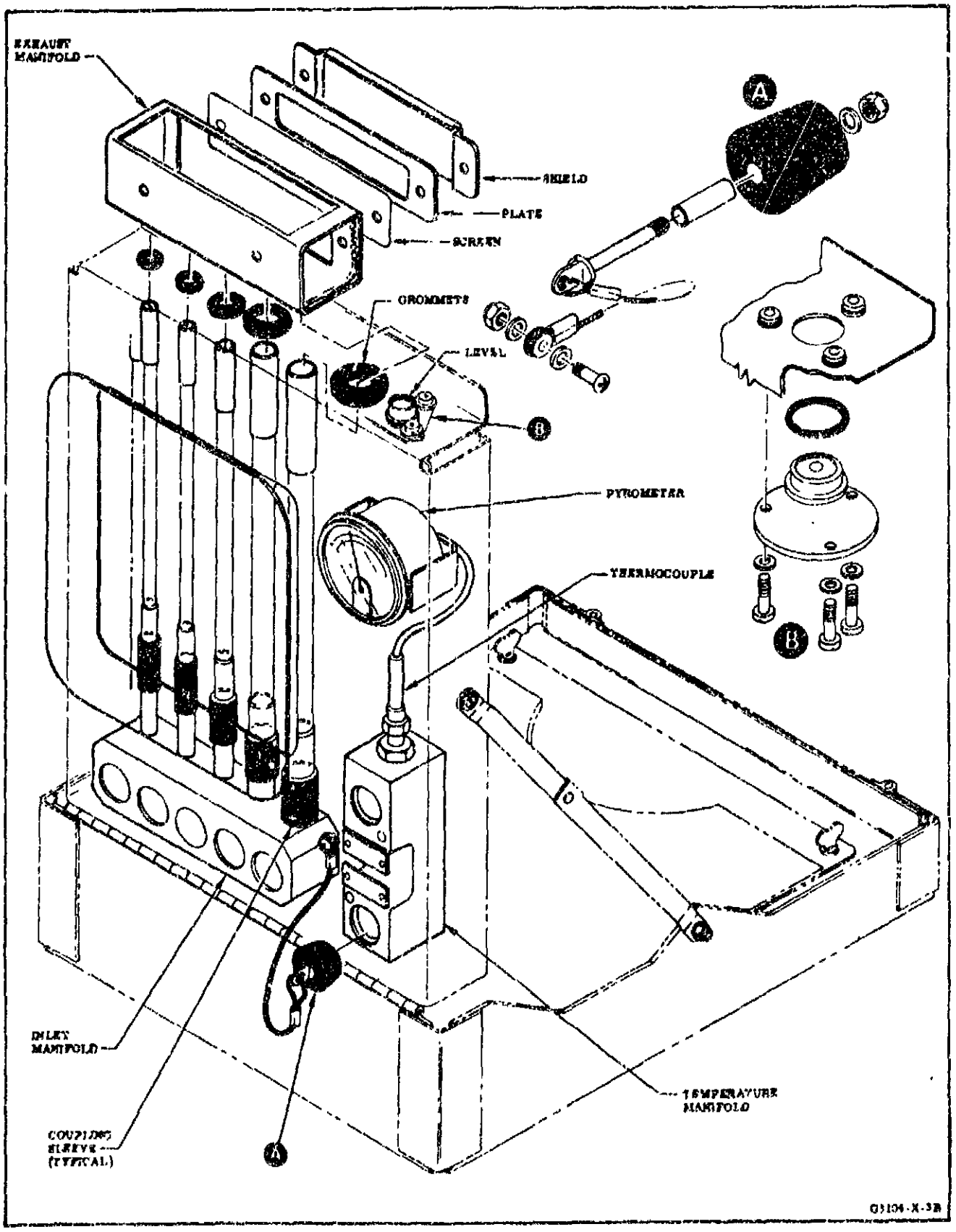

Figure 10-15. Pneumatic Flow Tester Components

c. Insert bottom end of flowmeter tube into coupling sleeve.

d. Insert flowmeter tube through rubber grommet in exhaust manifold, with tube scale facing forward.

e. Install flowmeter tube and coupling sleeve on inlet manifold nipple.

f. Install grommets, exhaust manifold, screen, plate, and shield. Torque screws to 12-14 inch-pounds.

10-32. REMOVING PYROMETER.

a. Disconnect thermocouple wires from temperature gage.

b. Remove thermocouple from temperature manifold. See figure 10-15.

c. Remove temperature gage and thermocouple through front of instrument panel. Handle thermocouple with care to avoid damage.

d. Separate pyrometer and thermocouple.

10-33. INSTALLING PYROMETER.

a. Connect thermocouple to pyrometer by installing blue wire to positive (+) terminal.

b. Install red wire to negative (-) terminal.

c. Function-test pyrometer by immersing thermocouple tip in clean, distilled water along with a thermometer (figure 10-9). Perform test at 3 temperatures between 55° and 95° F. Pyrometer must indicate within 3° F of thermometer indication.

d. Insert thermocouple, capillary tube, and pyrometer through front of instrument panel.

e. Install thermocouple and capillary tube on temperature manifold.

10-34. REMOVING AND INSTALLING LEVEL.

a. Remove safetywire, attaching screws, base plate, and packing, and remove level through rear of instrument panel.

b. Install level by placing packing on level, and inserting level through mounting hole in top of instrument panel. See figure 10-15.

c. Place base plate against bottom of level and install mounting screws to secure bubble level to instrument panel.

d. Install adjustment legs into bottom of case and adjust to level position using a reference level.

e. Adjust level to center bubble by tightening attaching screws. Safetywire screws with lockwire.

All data on pages 10-25 through 10-34 deleted.

SECTION XI

SIMULATOR PANEL 9024480-11

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

G1037, Electrical Checkout Console
G3121, Data Recorder Console

9024480-11, Simulator Panel

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11-7	MAINTENANCE OF SIMULATOR PANEL COMPONENTS	11-1

Underlined titles denote primary paragraphs.

11-1. DESCRIPTION AND LEADING PARTICULARS OF SIMULATOR PANEL.

11-2. The simulator panel (figure 11-1) is an electrical unit capable of simulating engine facility and engine controller electrical functions. The panel simulates engine components to check out the engine controller as a component or the controller and engine harness as a unit. Facility signals are also simulated during engine checkout, as well as signals of the engine pressure switches, ignition detector, and temperature detector during a simulated firing test. The panel monitors the helium vent bleed valve open position and verifies interim redundant controller circuitry, engine harness dual mainstage OK switch signal, and continuity of propellant utilization valve jumper. It also tests calips pressure switches and temperature transducers. The panel contains switches, indicator lights, relays, timers, receptacles, a grounding connector, and interconnecting circuitry. Potentiometers, test jacks, and a connector are provided for checkout and calibration of spark exciter monitor circuit boards. A fuse panel with indicator lights and spare fuses provides overload protection for the engine control assembly. The panel has provisions for mounting in a standard 19-inch rack. Actuating the FACILITY READY switch on the simulator panel permits individual check of each component circuit by moving the applicable component switch on the simulator panel. See figure 11-2 for simulator leading particulars.

11-3. MAINTENANCE REQUIREMENTS FOR SIMULATOR PANEL.

11-4. Maintenance tasks required on the simulator panel are listed in figure 11-3. Information presented lists the tasks to be performed, when the tasks shall be performed, and reference to data necessary to accomplish these tasks. For maintenance and troubleshooting information, see electrical schematic and simulator panel wiring diagram in section IV.

11-5. INSTALLING SIMULATOR PANEL.

11-6. The simulator panel can be installed in a standard 19-inch rack. When the simulator is used without a rack, a protective enclosure should be provided to protect the panel from damage. Panel chassis stud E1 is used for grounding. Simulator panel receptacles requiring mating connectors for installation are listed in figure 11-4. See electrical schematic and simulator panel wiring diagram, section IV to aid in panel installation.

11-7. MAINTENANCE OF SIMULATOR PANEL COMPONENTS.

11-8. Maintenance of components consists of adjusting time delay relays. (Refer to section IV.)

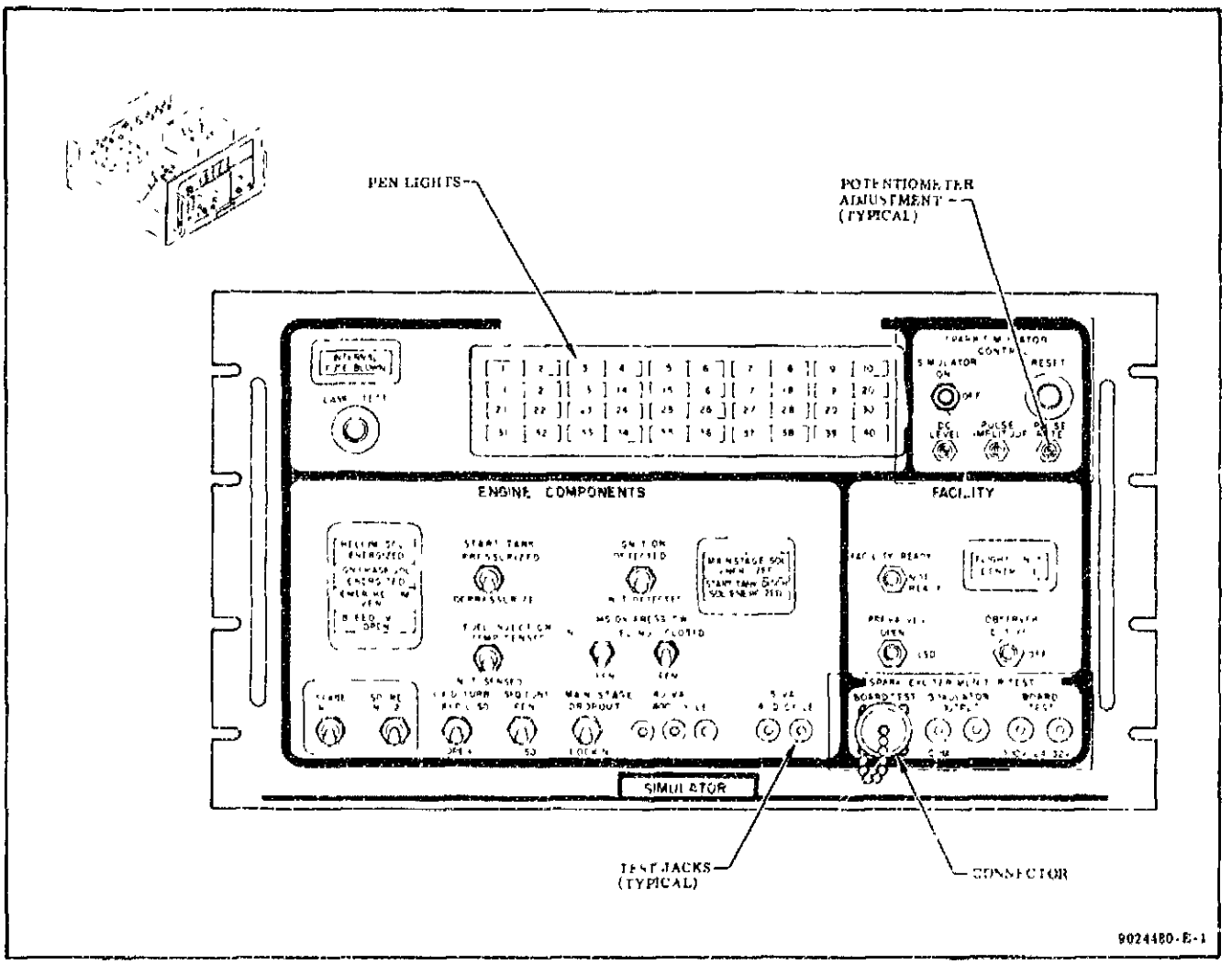

Figure 11-1. Simulator Panel

Dimensions	
Height	10.47 inches
Width	14.00 inches
Depth	17.18 inches
Electrical power	28 ±2 vdc
Fuses	
F1 through F5, F8, F9, and spare	1 ampere, GLD-1A (Bussmann)
F7, F10, F11, and spare	5 amperes, GLD-5A (Bussmann)

Figure 11-2. Leading Particulars for Simulator Panel

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Install protective caps on receptacles.			X	X	Whenever receptacles are not in use.
Clean panel.				X	As required to maintain cleanness of electrical circuitry. Frequency of cleaning depends on environment in which panel is used.
Function-test panel.				X	Prior to initial use, every 6 months, when repaired, or when a malfunction is suspected. Refer to section IV, for procedures.
Cover panel.			X		Wrap panel in greaseproof barrier material (MIL-B-121, Grade A), or equivalent.

Figure 11-3. Maintenance Requirements for Simulator Panel

Receptacle	Part Number	Receptacle	Part Number
J1	MS3102R32-7P	J4	MS3102R28-12P
J2	MS3102R36-10S	J5	10-169228-15P
J3	MS3102R22-19P	J6	MS3102R28-21P

Figure 11-4. Simulator Panel Receptacles

All data on page 11-4 deleted.

SECTION XII

COMPONENTS TEST CONSOLE G3107

WARNING

COMPONENTS TEST CONSOLE G3107 AND COMPONENTS ADAPTER SET 9016796 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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12-1. DESCRIPTION AND LEADING PARTICULARS.

12-2. The components test console (figure 12-1) is used to perform electrical, pneumatic, and cryogenic tests on components. The console consists of two major assemblies: a control console comprised of three cabinets containing the necessary panels to control and monitor pneumatic, electrical, and cryogenic tests, and a heavy-gage, clamshell cover test cell mounted on a rectangular cabinet. The test cell cover is actuated by two hydraulic cylinders mounted under the test cell at the rear of the cabinet. The test cell deck is the surface on which components are placed during test. The cabinet below the test cell encloses a hydraulic power pack unit and tubing, valves, and connectors which form a self-contained hydraulic system used to actuate the test cell cover. Also enclosed in the cabinet is a liquid nitrogen tank, tubing, and valves which form the cryogenic portion of the console. The entire console is designed for semi-permanent installation, with provisions on each assembly for leveling and forklift access. Three full-length doors at the rear of the control console permit access to components during checkout, calibration, and maintenance. Access to components of the test cell is obtained through doors on the rear and right side of the test cell assembly. See figure 12-2 for leading particulars.

12-3. COMPONENTS TEST CONSOLE PANELS.

12-4. The three cabinets of the control console contain the major portions of the pneumatic, electrical, and monitor systems. All operating controls, gages, and indicators are located on the front of the panels in each cabinet. The extreme left cabinet is entirely pneumatic, consisting of the following panels: pneumatic source control, system supply, high-pressure, medium-pressure, low-pressure, and liquid nitrogen tank pressure. The facility pneumatic inlet connections are located on the pneumatic source panel at the rear of the pneumatic cabinet. The center cabinet contains the following panels: propellant utilization valve position controller, low-pressure monitor, pressure/flow monitor, and pressure/ΔP monitor. The right-hand cabinet is primarily electrical and contains the following panels: component test power supply, power distribution, electrical control, oscilloscope, integrating digital voltmeter and pressure/temperature monitor. The facility electrical connection is located at the rear of the pneumatic cabinet on the pneumatic source panel.

12-5. TEST CELL PANELS.

12-6. The test cell deck includes panels at each end which contain the test and monitor connections. A component adapter is located in the test cell deck and is connected to the liquid nitrogen tank by a standpipe. Controls for the test cell cover, test cell lights, liquid nitrogen level indicator, and three 115-vac, 20-amp receptacles are located on a test cell utility panel at the front of the cabinet, below the test cell deck.

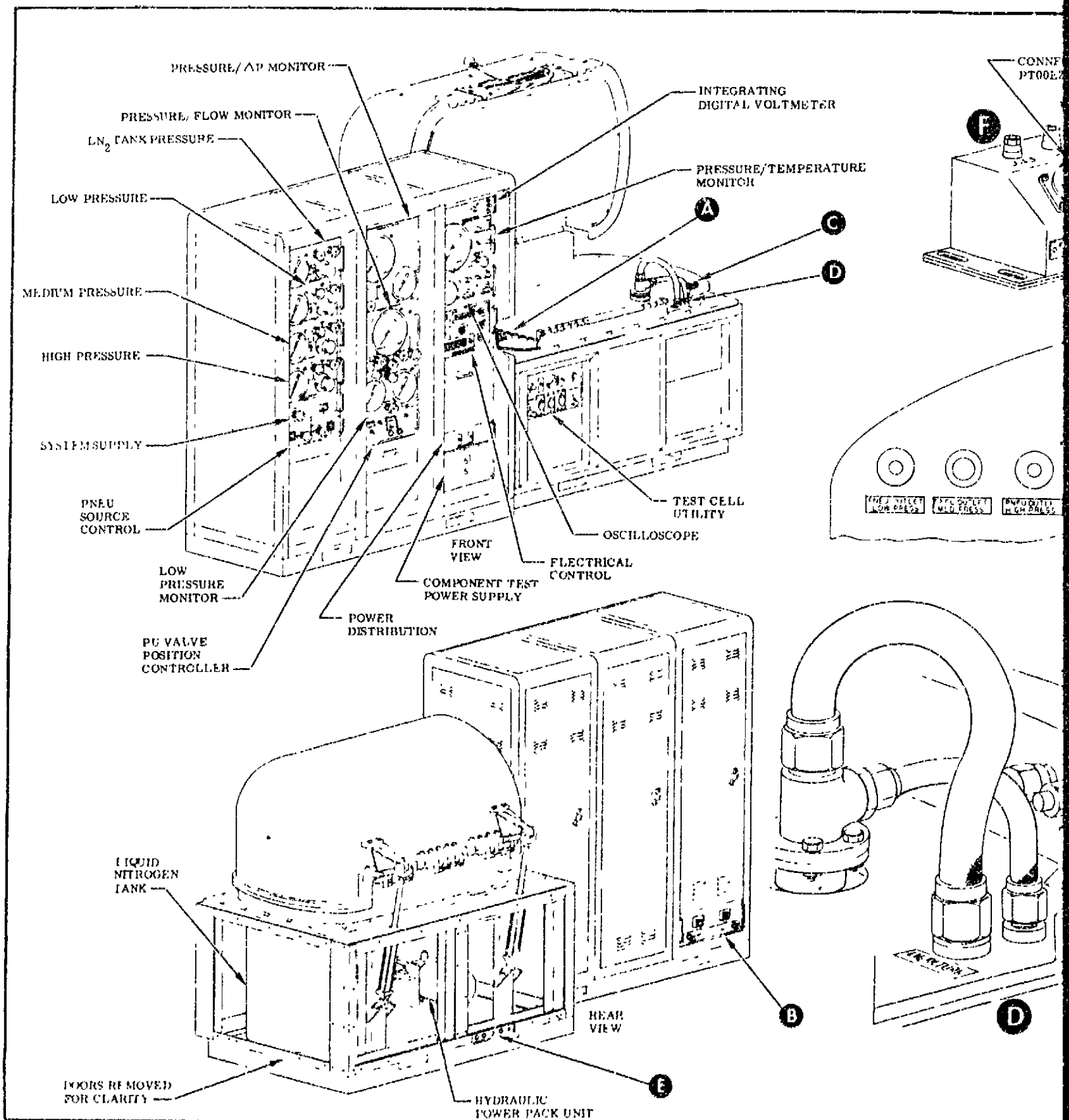
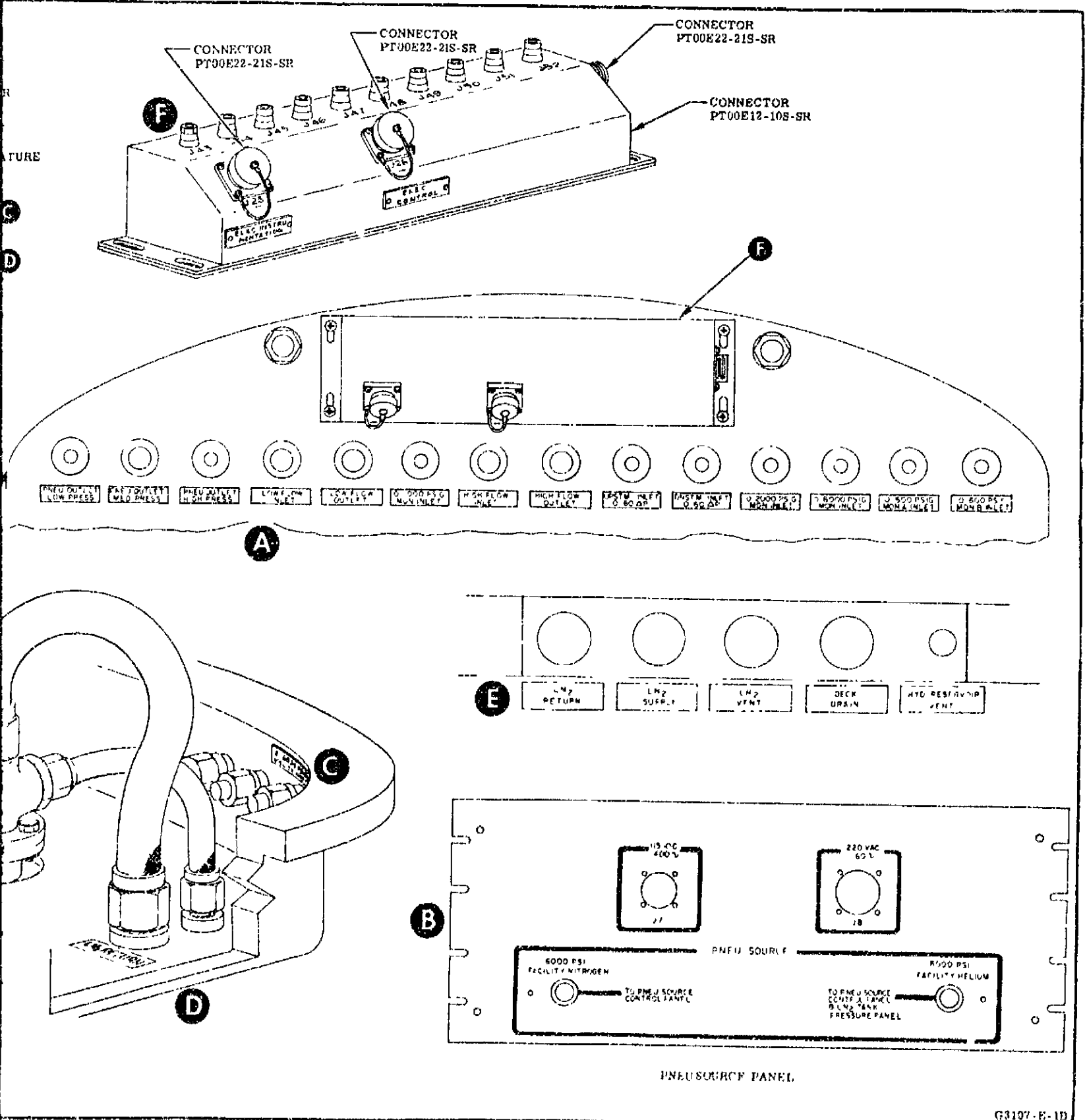


Figure 12-1. Components Test Console



PNEUSOURCE PANEL

Dimensions	
Control Console	
Height	78 inches
Width	30 inches
Length	72 inches
Test Cell	
Height	64 inches
Width	50 inches
Length	70 inches
Weight	
Control Console	1, 500 pounds, approximately
Test Cell	4, 500 pounds, approximately
Handling	
Test Cell	Fork-lift slots in base.
Control Console	Fork-lift slots in base.
Requirements	
Electrical	120/240 ±10/20 vac (rms) single-phase, 3-wire, 60 cycles, 50 amperes. 115 ±5 vac (rms) single-phase, 400 ±4 cps, 120 volt-amperes.
Facility Cables	
120/240 vac to receptacle J-8	Electrical wire (MIL-W-5086), 50-ampere minimum current capacity. Plug MS3106R24-10S; pins A and B, phase; pin C, ground; and pin D, neutral.
115 vac to receptacle J-7	Electrical wire (MIL-W-5086), 10-ampere minimum current capacity. Plug MS3106R18-4S; pin A, phase; pin B, neutral; pin C, ground; and pin D, shield

Figure 12-2. Leading Particulars (Sheet 1 of 3)

Helium	Bureau of Mines, Grade A. Refer to section I.
Nitrogen	MIL-P-27401. Refer to section I.
Hydraulic System	3 quarts Kel-F No. 10 heavy oil (Minnesota Mining and Mfg).
Cryogenic System	40 gallons liquid nitrogen (MIL-P-27401).
Performance	
Pneumatic Pressure	
Regulated	0-6,000 psig ±0.25% accuracy 0-2,000 psig ±0.25% accuracy 0-160 psig ±0.25% accuracy
Monitoring	0-6,000 psig ±0.10% accuracy 0-2,000 psig ±0.10% accuracy 0-1,000 psig ±0.10% accuracy 0-600 psig +0.25% accuracy Pressure differential of 60 psig maximum at 0-3,000 psig
Flow Measuring Capacities at 70° F(a)	
Low-Flow System	140 scim to 5.5 scfm at 200 psig 700 scim to 27.5 scfm at 1,000 psig
High-Flow System	4.8 scfm to 136 scfm at 200 psig 24 scfm to 680 scfm at 1,000 psig

(a) Capacities at pressures other than shown are directly proportional to the pressure used.

Figure 12-2. Leading Particulars (Sheet 2 of 3)

Filtration	10-micron absolute, (2-micron nominal)
Electrical[b]	
Output	110 vac, 20 amperes, 60 cps, single-phase
Monitoring	0-30 vdc 0-75 vdc 0-150 vdc 0-150 vac 0-50 milliamperes 0-250 milliamperes 0-500 milliamperes 500-1,000 milliamperes
Digital Voltmeter[b]	Measures up to ±1,000 volts, 5 ranges, including a ±0.1 volt range for high-resolution millivolt measurement.
Protection Devices	
Pneumatic	
System Relief Valves	6,400 ±320 psig
Liquid Nitrogen Tank Burst Diaphragm	1,500 psig
Electrical	
120/240 vac	50 amperes circuit breaker
115 vac	One ampere circuit breaker

(b) Additional information on oscilloscope and integrating digital voltmeter is in respective manuals stored in console.

Figure 12-2. Leading Particulars (Sheet 3 of 3)

12-7. ELECTRICAL SYSTEM.

12-8. The electrical system is a 120/240 volt, ac/dc system that supplies electrical power to components within the console and to the components being tested. The electrical system consists primarily of an electrical control panel which provides control, monitoring, and adjustment of test voltages and currents. The electrical control panel includes a patch-panel to extend test control and monitoring circuits to the components under test, including an adjustable 0-40 vdc, 5-amp

power supply to furnish dc voltage to components; an integrating digital voltmeter to monitor 0-4,000 cps flow transducer output; and oscilloscope to monitor valve timing and spark igniters; and a temperature indicator which reads thermotransducer temperature in the ranges of -260° to -190° F and +30° to +100° F. The operating and service manuals for the oscilloscope, Model 120B (Hewlett Packard Co), and integrating digital voltmeter, Model DY-2401B (Dymec Division of Hewlett Packard Co), are supplied with and stored in the components test console.

12-9. PNEUMATIC SYSTEM.

12-10. The pneumatic system is a nitrogen/helium system which distributes and regulates 6,000-psig inlet pressure to specific values required to test propulsion system components and to perform pneumatic functions within the console. The pneumatic system consists of a high-pressure panel, a medium-pressure panel, a low-pressure panel, a liquid nitrogen tank pressure panel, and a system supply panel that furnishes pressure to the high-, medium-, and low-pressure panels. The remainder of the system is a monitor system that is made up of high-, low-, pressure/flow-, and differential pressure panels. Components contained throughout the system are: an inlet filter, gages, hand valves, pressure regulators, relief valves, check valves, pressure switches, pressure transducers, flow transducers, inlet and outlet connections, and interconnecting plumbing. Pneumatic controls are located on the panels at the front of the control console and test cell and are mounted to provide ease of operation and readability.

12-11. HYDRAULIC SYSTEM.

12-12. The hydraulic system is used for the sole purpose of actuating the test cell cover to the open or closed position. The system is composed of a power pack unit which consists of a pump, a reservoir, a four-way solenoid, two actuating cylinders, four flow control valves, and tubing. Due to the extreme weight of the test cell cover, a safety feature is incorporated into the hydraulic controls to prevent inadvertent closing of the test cell cover. Operation of the cover requires that two separate controls be depressed simultaneously for the opening cycle and depressed simultaneously and continuously through the closing cycle, to preclude the possibility of the operator being in the area of the cover while it is actuated.

12-13. LIQUID NITROGEN SYSTEM.

12-14. The liquid nitrogen system is used to test components under cryogenic conditions. Pressure from the liquid nitrogen tank pressure panel supplies pressure to the liquid nitrogen tank at the specific values required when component test is performed. Components contained in the system are: a liquid nitrogen tank, a liquid nitrogen level indicator, a tank burst diaphragm, relief valves, shutoff valves, a solenoid valve, and interconnecting plumbing. Controls for the liquid nitrogen system are located on the liquid nitrogen tank pressure panel.

12-15. MONITOR SYSTEM.

12-16. The monitor system contains temperature-, pressure-, flow-, and differential-pressure sensing devices and instruments to visually observe the performance of the components within the console and the components being tested. The system consists of pressure gages, temperature transducers, flow transducers, an oscilloscope, a temperature indicator, a counter, hand valves, relief valves, and interconnecting plumbing and wiring. All monitor gages and controls are located on the control console monitor panels. Pneumatic, electrical, and liquid nitrogen monitor inlet and outlet connections are located on the test cell panels.

12-17. ACCESSORIES.

12-18. The accessories supplied with the console are patch-cords stored in the console storage drawer. See figure 12-3 for list of accessories.

Part Number	Nomenclature	Quantity
3088-1	Resistor patch-cord	1
3088-2	Resistor patch-cord	1
3088-3	Resistor patch-cord	1
3088-4	Resistor patch-cord	1
3088-5	Resistor patch-cord	1
3088-6	Resistor patch-cord	1
K2.06	Patch-cord	25
K2.09	Patch-cord	25
K2.15	Patch-cord	25
K9.06	Patch-cord	15
K9.09	Patch-cord	15
K9.15	Patch-cord	15

Figure 12-3. Accessories

12-19. THEORY OF OPERATION.

12-20. The component to be tested is placed in the console test cell and connected to electrical, pneumatic, monitoring, flow, or cryogenic systems as required. The test cell cover, actuated by a self-contained hydraulic system, may be closed during testing by simultaneously depressing and holding both controls until cycle is complete. Pneumatic sources of helium and nitrogen are supplied to the console pneumatic source control panel where the pressurant to be used is selected and supplied through the system supply panel to the high-, medium-, and low-pressure panels. The pressure required to test the component is regulated on the high-, medium-, or low-pressure panel (or combination of panels) and flows through test cell outlets to component being tested. The pressurant also actuates a pressure switch, indicating that the system is pressurized. Monitor gages, located on console panels and connected to the component being tested through test cell outlets, indicate pressures. Pressurant flowing through the flow transducers are measured and registered on the digital voltmeter. During a cryogenic test, liquid nitrogen from a storage tank below the test cell is supplied to the component being tested by regulating helium pressure from the liquid nitrogen tank pressure panel. Facility electrical power is supplied to the propellant utilization position controller panel and to the power distribution panel which supplies power to the console electrical components and panels. Electrical power is routed through patch-cords installed in the patch-boards of the electrical control panel, through test cell outlets, to the component being tested. Electrical signals from the component being tested are routed through the electrical control panel patch-boards to the monitoring electrical panels.

12-21. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

12-22. Modifications incorporated changing console configuration are listed in figure 12-4.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-349	1	21 May 1965
J2-536	2	19 July 1967

Figure 12-4. Configuration Changes--Manual Effectivity

12-23. PREPARING COMPONENTS TEST CONSOLE FOR USE.

12-24. The console is shipped as two assemblies and must be installed in environmental clean room and assembled. After initial installation and assembly is accomplished, it is only necessary to prepare the console systems for use as required by component being tested.

12-25. INSTALLING AND ASSEMBLING.

12-26. Install components test console in a clean room and as follows:

NOTE

All tubing assemblies supplied and fabricated must be inspected for use with indirect oxygen service.

a. Place console where a minimum of 4 feet clearance is obtainable to back and test cell ends of console, to ensure adequate clearance to fully open hinged access doors.

b. Level test cell flange by turning the 6 adjustable legs. Ensure that each leg supports a share of test cell weight.

c. Position pneumatic console next to and 3/8 inch forward of test cell assembly.

d. Level pneumatic console by turning the 4 adjustable legs until the 2 stripes on test cell and console assemblies are alined and a level placed at a corner on front and sides of console indicates a vertical condition.

e. Remove blank panel above POWER DISTRIBUTION panel.

f. Remove blank panel below test cell utility panel.

g. Disconnect 2 tube assemblies from LN_2 LEVEL indicator gage and cap open ports.

h. Disconnect electrical plugs P36 and P37 from receptacles J36 and J37.

i. Remove test cell utility panel.

j. Connect tube assemblies between pneumatic console and test cell tube assemblies, in the order listed in figure 12-5. Refer to section 1 for lubricating tube assemblies.

NOTE

Interconnecting tube assemblies are packaged and stored inside storage drawer of console.

k. Secure tube assemblies with clamps provided.

l. Install oscilloscope panel on console.

m. Connect plug P302 to oscilloscope HORIZONTAL receptacle.

Console Assembly Tube	Interconnecting Tube	Torque Value (Inch-Pounds)	Test Cell Assembly Tube
9022394	9022377	480-540	9022357
9022397	9022370	432-480	9022396
9022408	9022404	432-480	9022403
9022371	9022406	432-480	9022405
9022584	9022583	120-144	9022356
9022515	9022516	120-144	9022517
9022374	9022375	120-144	9022376
9022484	9022487	120-144	9022488
9022402	9022401	120-144	9022399
9022482	9022472	120-144	9022475
9022483	9022489	120-144	9022478
9022413	9022414	120-144	9022415
9022410	9022411	120-144	9022412
9022379	9022380	432-480	9022381
9022617	9022618	450-525	9022619
9022385	9022386	120-144	9022387

Figure 12-5. Interconnecting Tube Assembly List

n. Connect plug P303 to oscilloscope VERTICAL receptacle.

o. Connect oscilloscope power supply cord to receptacle J604A located on side strut of pneumatic console.

p. Coil excess oscilloscope power supply cord and secure it with clamp provided on pneumatic console strut.

q. Connect the following wiring harnesses and wiring assemblies:

(1) 9022608 between receptacle J701 and plug P25 (and plugs P43 through P52).

(2) 9022609 between receptacles J702 and J34, and plug P26.

(3) 9022634 between receptacles J703 and J36.

r. Fabricate facility power cable to specification outlined below and connect it to 115-vac, 400-cps receptacle J7 on PNEU SOURCE panel:

(1) Electrical wire (MIL-W-5086) with minimum current capacity of 10 amperes.

(2) Plug MS3106R18-4S.

(3) Pin A. Phase.

(4) Pin B. Neutral.

(5) Pin C. Ground.

(6) Pin D. Shield.

NOTE

Shielded wire on the facility cable must be connected to power supply ground to complete grounding system.

s. Fabricate facility power cable to specification outlined below and connect it to 220-vac, 60-cps receptacle J8 on PNEU SOURCE panel:

(1) Electrical wire (MIL-W-5086) with minimum current capacity of 50 amperes.

(2) Plug MS3106R24-10S.

(3) Pin A. Phase.

(4) Pin B. Phase.

(5) Pin C. Ground.

(6) Pin D. Neutral.

t. Fabricate 2 facility pressure lines, using 1/4-inch tubing tail piece 448R-4-347 and nuts 450N-4-300 (Combination Pump Valve Co).

u. Proof-pressure-test facility pressure lines at 12,000 ±1,000 psig for 2 minutes. Vent pressure and repeat procedure 4 times. No permanent deformation is allowable. Clean lines (section I).

v. Connect one line and packing MS28778-2 between facility helium supply connection and 0-6000 PSI FACILITY HELIUM connection. Connect other line and packing MS28778-2 between facility nitrogen supply connection and 0-6000 PSI FACILITY NITROGEN connection on PNEU SOURCE panel at rear of pneumatic console.

WARNING

High-pressure lines must be secured to prevent whipping. Whipping high-pressure lines can cause serious injury to personnel and damage to equipment.

w. Install test cell utility panel on front of test cell.

x. Connect tubing assemblies to each side of LN_2 LEVEL indicator gage. Torque nuts to 135-185 inch-pounds.

y. Connect plug P37 to receptacle J37 on test cell utility panel.

z. Remove bottom plug from body of regulator mounted on MEDIUM PRESSURE panel.

aa. Fabricate and connect vent lines between placarded connections at rear of test cell and connections leading to outside of clean room.

(1) HYD RESERVOIR VENT, 1/4-inch line.

(2) DECK DRAIN, 3/4-inch line.

(3) LN_2 RETURN, 3/4-inch line.

(4) LN_2 VENT, 3/4-inch line.

ab. Remove pressure plugs and/or protective closures from all vent and relief valve outlets. Ensure that all of these outlets are open by checking relief valves

and vent valves in areas listed in figure 12-6. Outlets of relief valves located below test cell are connected to liquid nitrogen vent system and do not have pressure plugs or protective closures installed.

WARNING

Pressurizing the components test console with relief valve or vent valve outlets capped can result in overpressurizing system, causing an explosion resulting in serious injury or death and damage to equipment.

Accessible Through(a)	Item	Approximate Location
Right-hand access door (control console)	Four relief valves Four vent valves	Two relief valves are mounted on channel on left-hand side of bay. Two relief valves are mounted on channel on right-hand side of bay. One vent valve is mounted on each of the following panels: a. LOW PRESSURE. b. MEDIUM PRESSURE. c. HIGH PRESSURE. d. SYSTEM SUPPLY.
Center access door (control console)	Five relief valves Two vent valves	One relief valve is below and to right of 0-2000 psi gage on PRESSURE/Δ P MONITOR panel. One relief valve is connected to cross fitting on gage on PRESSURE FLOW MONITOR panel. Two relief valves are between (one above and one below) the two 0-600 psi gages mounted on LOW PRESSURE MONITOR PANEL.

(a) As viewed facing rear of console.

Figure 12-6. Relief and Vent Valve Location (Sheet 1 of 2)

Accessible Through(a)	Item	Approximate Location
		Two vent valves are between (one above and one below) the two 0-600 psi gages mounted on LOW PRESSURE MONITOR PANEL.
		One relief valve (in HIGH FLOW INLET system) is immediately forward of lower left-hand corner of metallic mounting plate across bay.
Left-hand access door (control console)	One relief valve One vent valve	Relief valve is on right-hand side of bay directly below OSCILLOSCOPE panel.
		Vent valve is mounted on PRESSURE/TEMPERATURE MONITOR panel.
Right-hand access door below test cell	One relief valve	Adjacent to hinged side of door.
Either right- or left-hand access door below test cell	One relief valve	Connected to tee fitting from LN_2 storage tank.

(a) As viewed facing rear of console.

Figure 12-6. Relief and Vent Valve Location (Sheet 2 of 2)

ac. Test console (paragraph 12-41).

ad. After completing tests, install blank panels above POWER DISTRIBUTION panel and below test cell utility panel.

12-27. PREPARING FOR ELECTRICAL USE.

12-28. Preparing the console for electrical use consists of performing the following steps and then only the procedures (paragraphs 12-29 through 12-33) necessary to meet the requirements of the tasks for which the console is being used:

a. Ensure that all toggle switches are to OFF or lowermost position, and rotary switches are to OFF or DECREASE. Position of rotary switches without OFF or DECREASE position is optional.

b. Ensure that all circuit breakers are in deenergized position.

c. Make sure that facility power is supplied to J7 and J8 receptacles at rear of console.

d. Unless cryogenic temperature transducer is to be used, pull out ELECTRICAL CONTROL panel and make sure that resistance patch-cord 3088-8 is installed between jacks A2-9D and A2-9E. This resistance patch-cord must be installed as noted whenever cryogenic temperature transducer is not used.

e. Make sure that patch-cord plugs 3088-9 are installed in receptacles RTD4, RTD5, and RTD6 on rear of temperature indicator panel. These patch-cord plugs contain a resistive circuit to prevent damage to instrument if CHANNEL SELECT switch is positioned to unused channels 4 through 6.

f. Depress 5 AMP, 20 AMP, and 50 AMP circuit breakers on POWER DISTRIBUTION panel. Depending on status of switch-lights when console was previously deactivated, ON or STANDBY light comes on; individual switch-lights 1 through 8 on ELECTRICAL CONTROL panel and PRESS TO VENT TANK switch-light on LN_2 TANK PRESSURE PANEL may come on.

g. Actuate noted switch-lights as necessary to obtain the following results:

(1) ON-STANDBY switch-light, ON light on.

(2) 1 through 8 switch-lights on ELECTRICAL CONTROL panel, and PRESS TO VENT TANK light on LN_2 TANK PRESSURE panel, off.

h. Depress CIRCUIT BREAKER on test cell utility panel when electrical power is desired at 115 VAC 30 AMP electrical outlets.

i. Complete preparation of console for electrical use by performing those procedures in paragraphs 12-29 through 12-33 that are necessary to meet the requirements of the task for which the console is to be used.

12-29. PRE-USE ADJUSTMENT OF DIGITAL VOLTMETER. Prior to each use, the digital voltmeter must be checked and adjusted as follows:

a. Prepare console for electrical use (paragraph 12-27).

b. Make sure that the following switches (mounted on back of digital voltmeter and accessible from rear of console) are positioned as follows:

(1) Count switch to DISPLAY DURING COUNT.

(2) 100 KC STD switch to INT.

(3) AC LINE VOLTAGE switch to 115. Switch position is noted on slide portion of switch adjacent to plastic actuating knob.

c. Position toggle switch to ON.

d. Allow 30-minute warm-up period before continuing with test.

e. Position RANGE selector to ZERO.

f. Position FUNCTION selector to VOLT.

g. Position SAMPLE PERIOD selector to START and then to 1 SEC 100 PER. Digital voltmeter must indicate a count of 0 ±1. If indicated count is not within tolerance, perform step h. If indicated count is within tolerance, proceed to step i.

h. Adjust ZERO potentiometer until indicated count is 0 ±1. Gain access to ZERO potentiometer by removing small plastic plug immediately below ZERO position of range switch. Replace plastic plug when adjustment is complete.

i. Position RANGE selector to INT + IV. Digital voltmeter must indicate +1000.00 ±0.05 MILLIVOLTS. If indication is not within tolerance, perform steps j through l. If indication is within tolerance, proceed to step m.

j. Adjust CAL+ potentiometer until digital voltmeter indicates +1000.00 ±0.05 MILLIVOLTS. Gain access to CAL+ potentiometer by removing small plastic plug immediately below CAL+ nomenclature on face of digital voltmeter. Replace plastic plug when adjustment is complete.

k. Position RANGE selector to ZERO.

l. Repeat step g.

m. Position RANGE selector to INT-IV. Digital voltmeter must indicate -1000.00 ±0.05 MILLIVOLTS. If indication is not within tolerance, perform steps n through p. If indication is within tolerance, pre-use adjustment of digital voltmeter is complete.

n. Adjust CAL- potentiometer until digital voltmeter indicates -1000.00 ±0.05 MILLIVOLTS. Gain access to CAL- potentiometer by removing small plastic plug immediately below CAL- nomenclature on face of digital voltmeter. Replace plastic plug when adjustment is complete.

o. Position RANGE selector to ZERO.

p. Repeat step g.

12-30. PREPARING FOR FREQUENCY MEASUREMENTS.

a. Perform pre-use adjustment of digital voltmeter (paragraph 12-29).

NOTE

Controls noted in this procedure are on the DIGITAL VOLTMETER.

b. Set FUNCTION selector to FREQ.

c. Set ATTEN selector to CHECK (switched position).

d. Set SAMPLE PERIOD selector to one of the 3 fixed periods: 1 SEC 100 PER, .1 SEC 10 PER, or .01 SEC 1 PER.

e. Set SAMPLING RATE control to a convenient rate. The instrument reading, in kc, must be as follows (±1 count):

Sample Period	Reading
0.01 second	0010.0
0.1 second	010.00
1.0 second	10.000

f. Set SAMPLING RATE control to STOP (switched position).

g. Connect frequency source to instrument by using one of the means in the following substeps: (If patch-cord jacks are to be utilized, momentarily depress ON-STANDBY switch-light on ENGINE CONTROL panel. STANDBY light comes on and ON light goes off. When connecting to patch-board jacks is completed, momentarily depress ON-STANDBY switch-light. ON light comes on and STANDBY light goes off.)

(1) FREQ INPUT connector on front panel. Outer conductor of connector is connected to instrument chassis.

(2) Patch-board jacks A2-10A and A2-10B. Jack A2-10B is connected to instrument chassis.

(3) Electrical posts in test cell. Installation of patch-cords is required to complete circuitry from selected electrical posts and patch-board jacks A2-10A and A2-10B. See figure 12-10 to determine required patching. Patch-board jack A2-10B is connected to instrument ground.

h. Momentarily depress RESET button. Frequency is displayed in kilocycles, with decimal point automatically positioned.

i. Turn ATTEN control clockwise approximately 30 degrees past point where consistent measurements are obtained.

12-31. PREPARING FOR DC VOLTAGE MEASUREMENTS USING DIGITAL VOLTMETER. To prepare the console for voltage measurements, refer to the Integrating Digital Voltmeter manual, provided with equipment, for operating procedures. Voltage signals may also be connected to electrical posts in test cell and the electrical control panel patched as required. See figure 12-10 to determine required patching.

a. Connect voltages to be measured as follows:

(1) Plus dc voltages to patch-board jacks A2-7A or A2-7C, or H1 jack on face of DIGITAL VOLTMETER panel.

(2) Minus dc voltages to patch-board jack A2-7D or to L0 jack on face of DIGITAL VOLTMETER panel.

(3) Shield ground to patch-board jack A2-7F or to GUARD jack on face of DIGITAL VOLTMETER.

b. Supply power to digital voltmeter by preparing console for electrical use (paragraph 12-27).

12-32. PREPARING FOR OSCILLOSCOPE USE. To prepare console for oscilloscope use, refer to the oscilloscope manual, provided with equipment, for operating procedures. Signals may also be connected to electrical posts in test cell and the electrical control panel patched as required. See figure 12-10 to determine required patching.

a. Connect signals to be measured as follows:

(1) Horizontal input signal to patch-board jacks A2-8A or A2-8C, or to EXT. SYNC OR HORIZ jack (red) on face of OSCILLOSCOPE panel.

(2) Ground to patch-board jack A2-8D or to middle jack (black) on face of OSCILLOSCOPE panel.

(3) Vertical input signal to patch-board jack A2-8F or to right vertical jack (red) on face of OSCILLOSCOPE panel, when facing panel.

(4) Ground to patch-board jack A2-8E or to vertical jack (black) on face of OSCILLOSCOPE panel, when facing panel.

b. Supply power to oscilloscope by preparing console for electrical use (paragraph 12-27).

12-33. PREPARING FOR TEMPERATURE MEASUREMENTS. The temperature indicator indicates temperature of the gases in the high-flow system, the low-flow system, or the cryogenic range. A temperature transducer and patch-cords supplied in the components adapter set are utilized when measuring temperatures in the cryogenic range. To measure temperatures of gases in either flow system, perform steps a through d; in the cryogenic range, steps e through i.

a. Pull out ELECTRICAL CONTROL panel and install single patch-cords K2 to the following jacks of selected system:

(1) Low-flow system: A2-10A to A2-10C and A2-10B to A2-10D.

(2) High-flow system: A2-10A to A2-10E and A2-10B to A2-10F.

b. Close ELECTRICAL CONTROL panel.

c. Prepare console for electrical use as outlined in paragraph 12-27.

d. Rotate CHANNEL SELECT switch to the desired position:

(1) Low-flow system: position 2.

(2) High-flow system: position 3.

e. Pull out ELECTRICAL CONTROL panel and install single patch-cords K2 between the following jacks:

(1) A2-9C to A2-9G.

(2) A2-9D to A2-9H.

(3) A2-9E to A2-9I.

(4) A2-9F to A2-9J.

f. Close ELECTRICAL CONTROL panel.

g. Connect cable 103310 to temperature transducer and to ELEC INSTRUMENTATION connector J25 on electrical test cell panel. Obtain temperature transducer and cable from components adapter set.

h. Prepare console for electrical use as outlined in paragraph 12-27.

i. After cryogenic temperature transducer has been in contact with low-temperature medium long enough to effect a temperature soak of transducer, rotate CHANNEL SELECT switch to position 1.

CAUTION

Moving CHANNEL SELECT switch to position 1 without sufficient temperature soak of the transducer can peg the instrument indicator and damage it.

12-34. PREPARING FOR PNEUMATIC USE.

12-35. Preparing console for pneumatic use consists of performing the following steps then paragraphs 12-36 and 12-37 as required to meet requirements of tasks for which console is being used.

a. Ensure that all panel-mounted hand valves are closed.

b. Ensure that the 6 gage isolation valves are open. These valves are located inside console and are accessible through right hand access door as viewed from rear of console.

c. Ensure that all GAGE TEST connections are pressure-capped and tight.

d. Ensure that the following outlets located at rear of test cell are open to atmosphere:

(1) LN_2 VENT.

(2) DECK DRAIN.

(3) HYD RESERVOIR VENT.

e. Ensure that the 3 valves in the LN_2 system, inside console and below test cell, are closed.

f. Open facility supply of test media to be used. Facility pressure is indicated on appropriate SOURCE PRESS gage on PNEU SOURCE CONTROL panel.

NOTE

Helium is used exclusively in the LN_2 system and must be supplied to the console if the LN_2 system is to be used.

12-36. PREPARING FOR FLOW MEASUREMENTS. To prepare the digital voltmeter for frequency measurement, refer to the Integrating Digital Voltmeter operation manual, provided with equipment, for operating procedures. A frequency of 1,000 cps can be obtained from the low-flow system and 600 cps from the high-flow system.

a. Install the following patch-cords:

(1) High-flow system: install a patch-cord from A2-10A to A2-10E and a patch-cord from A2-10B to A2-10F.

(2) Low-flow system: install a patch-cord from A2-10A to A2-10C and a patch-cord from A2-10B to A2-10D.

b. Supply power to the digital voltmeter by preparing the console for electrical use (paragraph 12-27).

c. Refer to paragraph 12-33 for measuring temperature of gases.

12-37. PREPARING FOR CRYOGENIC USE.

a. Prepare console for electrical use as outlined in paragraph 12-27. There is no requirement for electrical power at the 115 VAC 30 AMP electrical outlets; therefore, CIRCUIT BREAKER on test cell utility panel need not be depressed.

b. Open test cell cover.

c. If installed, remove hose connected to tee at top of LN_2 tank to LN_2 RETURN port.

d. Connect cryogenic hand valve to tee at top of LN_2 tank.

e. If test requires the submersion of a component in LN_2, place environmental test chamber in test cell and connect it to the cryogenic hand valve. If test requires flowing LN_2 through a component, connect a cryogenic hand valve to LN_2 RETURN port in test cell.

f. Fill LN_2 storage tank (paragraph 12-38).

12-38. FILLING LIQUID NITROGEN STORAGE TANK.

a. Prepare console for cryogenic use (paragraph 12-37).

b. Open cryogenic hand valve connected to tee at top of LN_2 tank.

c. Close test cell cover.

d. Ensure that LN_2 return and LN_2 SUPPLY valves are closed and LN_2 tank vent valve is open. These valves are inside cabinet below test cell.

e. Ensure that facility LN_2 is available to console LN_2 SUPPLY port.

f. Open LN_2 SUPPLY valve (inside cabinet below test cell) until desired liquid level is indicated on LN_2 LEVEL gage, then close LN_2 SUPPLY valve. After a short stabilization period, gage may indicate a lower level; if necessary, repeat step until required level is maintained. Each inch of gage indicator is approximately 2 gallons. Do not exceed maximum capacity of 20 inches.

WARNING

Do not allow any part of the body to come in contact with frozen or extremely cold material. Human tissue will freeze upon contact, causing serious injury.

g. Open test cell cover and close cryogenic hand valve connected to tee at top of LN_2 tank.

h. Close LN_2 tank vent valve (inside cabinet below test cell).

12-39. MAINTENANCE OF COMPONENTS TEST CONSOLE.

12-40. Maintenance tasks required on the components test console are listed in figure 12-7. Information presented lists the tasks to be performed, when the tasks must be performed and reference to data necessary to perform the tasks.

12-41. TESTING.

12-42. Testing components test console consists of electrical function- and pneumatic and hydraulic leak- and function-tests. See figures 12-8 for a pneumatic schematic, figure 12-9 for an electrical block diagram, and figure 12-10 for an electrical schematic.

12-43. TEST REQUIREMENTS. Test conditions, leak-test requirements, safety precautions, test cell connections, and external hose requirements are as follows:

a. Checkout of the console must be performed at ambient test conditions, at temperatures of 68° to 78° F, at a barometric pressure of 28-32 inches of mercury, and at a humidity not greater than 55 percent.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect console for completeness.	X	X			Refer to paragraph 12-17.
Inspect electrical cables for broken or frayed insulation and damaged connectors.	X				Replace damaged cable. See figure 12-9.
Inspect tube assemblies for:					Torque loose coupling nut. Refer to torquing in section I.
Loose coupling nuts	X				
Deformation	X				Replace damaged tube assembly.
Paint console panels, control console interior, and test cell interior.				X	Whenever painted surfaces are damaged, use enamel (Federal Specification TT-E-529); color 26440 (Federal Standard 595).
Paint control console exterior, test cell exterior, and test cell deck.				X	Whenever painted surfaces are damaged, use enamel (Federal Specification TT-E-529); color 26251 (Federal Standard 595).
Fill hydraulic system.				X	Whenever liquid is not observed in sight gage. Refer to paragraph 12-55.
Test console.				X	Every 6 months. Refer to paragraph 12-41 and perform abbreviated test if console has not been modified, repaired, or moved. Test completely every 2 years minimum or after modifying, repairing, or moving.
Test patch-cords.				X	Every 6 months, or subsequent to repair. Refer to paragraph 12-72.
Check accuracy of pressure gages.				X	Every 6 months. Refer to paragraph 12-48.
Check accuracy of flowmeters.				X	Every 6 months. Refer to paragraph 12-49.
Check accuracy of ΔP gage.				X	Every 6 months. Refer to paragraph 12-50.

Figure 12-7. Maintenance Requirements (Sheet 1 of 2)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Calibrate oscilloscope.				X	Every 6 months. Refer to paragraph 12-51.
Calibrate digital voltmeter.				X	Every 6 months. Refer to paragraph 12-52.
Check accuracy of voltmeter, ammeter, and valve opening percent meter.				X	Every 6 months. Refer to paragraph 12-53.
Calibrate temperature indicators.				X	Every 6 months. Refer to paragraph 12-54.
Clean console interior and exterior surfaces.				X	Prior to installation and to maintain level of cleanness. Refer to section I.
Lubricate console hand valves.				X	Every 12 months or whenever valves develop binding between lubrication periods.
Prepare console for storage.				X	Whenever console is not to be utilized. Refer to paragraph 12-58.
Prepare console for shipment.				X	Whenever console is to be relocated. Refer to paragraph 12-60.
Inspect control console and test cell for indication of humidity.			X		Forty-eight hours after installation of desiccant and every 60 days thereafter. If humidity is indicated, change desiccant. Refer to paragraph 12-58.

Figure 12-7. Maintenance Requirements (Sheet 2 of 2)

b. Leak-testing of pneumatic connections must be performed by applying leak-test compound (MSFC-SPEC-384) on all pressurized connections. No leakage is allowable at connections, as indicated by absence of bubble growth over a 5-minute period. Connections on hydraulic system must be checked for leakage by observing pressurized part for presence of fluid. No leakage of fluid is allowable at pressurized connections.

c. Personnel in immediate area must protect themselves from injury by wearing appropriate safety goggles or visors and clothing.

d. Fittings or connections must not be tightened, loosened, or removed while the system is pressurized.

e. When fittings, lines, or components are disconnected, they must be protected from foreign material by installation of appropriate protective coverings:

f. All test cell pneumatic inlet and outlet connections, except the utility connections, are adapters (Combination Pump Valve Co). During leak- and function-tests, these adapters must be replaced, as required with AN-type fittings.

g. All external hoses must have Teflon as inner lining material. All external hoses, fittings, lines, and components used in checkout must be cleaned for liquid oxygen service. Refer to cleaning in section I.

h. Whenever test requires a continuity check, the multimeter indication must be less than one ohm.

12-44. TEST EQUIPMENT. The following test equipment is required to test the components test console:

a. Facility power capable of supplying 120/240 ±10/20 vac, single-phase, operating at a frequency of 60 cps and rated at 50 amps.

b. Facility power capable of supplying 115 ±5 vac, single-phase, operating at a frequency of 400 ±4 cps and rated at 120 volt-amperes.

c. Regulated source of gaseous nitrogen capable of supplying a minimum of 6,800 psig at a maximum flow of 500 scfm. Nitrogen must conform to requirements specified in section I.

d. Regulated source of helium capable of supplying a maximum of 5,000 psig at a maximum flow of 800 scfm. Helium must conform to requirements specified in section I.

e. Eighty to 100 gallons of liquid nitrogen (MIL-P-27401).

f. Multimeter, Model 630-A (Triplett), or equivalent.

g. Leak-test compound (MSFC-SPEC-384).

h. Patch-cords provided with the electrical control panel.

i. Test hoses from components adapter set 9016796.

j. Obtain the following equipment only when testing consoles incorporating MD2 change:

(1) Cable 103198 (9026548) from components adapter set 9016796.

(2) Universal test lead kit 699 from components adapter set 9016796.

(3) Actuator assembly NA5-26726 or propellant utilization valve 251351-11. (Actuator or valve must be in operable condition.)

12-45. LEAK- AND FUNCTION-TESTING (CONSOLES NOT INCORPORATING MD2 CHANGE). Testing the console requires checking all relief valves for proper opening pressures. Two of the relief valves have an opening pressure of 6,400 ±320 psig, which is above the operating pressure of the console. These valves may, at the option of personnel performing the test and with adequate safeguards, be tested while installed in the console. Applying pressures above the operating range of the console is permissible, with adequate safety measures, since the console has been proof-tested to 9,000 psig. A minimum of 6,750 psig of helium pressure must be available to the console to test these valves while installed. If the operator chooses not to test these valves while installed, they must be removed, checked to the requirements of step cc, and reinstalled prior to beginning this test. Procedures include a complete and an abbreviated test. A complete test is accomplished by performing all steps in the procedure. An abbreviated test is accomplished by omitting steps preceded by an asterisk. As an aid in trouble-shooting, see figures 12-8 through 12-18 for schematics and wiring diagrams.

a. Prepare console for electrical use (paragraph 12-27). Preparation of individual electrical panels for electrical use is not necessary, since the remaining electrical panels are energized as required during the test.

b. Depress LAMP TEST switch on ELECTRICAL CONTROL panel. SYSTEM PRESSURIZED light and all lights on ELECTRICAL CONTROL panel come on. Release LAMP TEST switch. All lights go off except ON light.

c. Momentarily depress ON-STANDBY switch on ENGINE CONTROL panel, STANDBY light comes on and ON light goes off.

CAUTION

Patch-board circuits must be deenergized before installing patch-cords, since installation of patch-cord in the wrong jack can cause damage to equipment.

d. Pull out ELECTRICAL CONTROL panel and install patch-cords between the following jacks: (Use dual patch-cords K9 when connections are coded*. In all others, single patch-cords K2 or dual patch-cords K9 may be used.)

A1-1A to A1-10B*	A1-3B to A2-6D	A1-8C to A2-6E
A1-2A to A1-9B*	A1-4B to A1-8B	A1-5E to A2-8C
A1-3A to A1-4A	A1-7B to A1-4C	A1-6E to A2-8D
A1-5A to A1-10B	A1-1C to A1-10D	A2-10A to A2-10E
A1-6A to A1-9B	A1-2C to A1-9D	A2-10B to A2-10F
A1-7A to A1-5B	A1-3C to A2-6F	A2-8E to A2-4J*
A1-8A to A1-6B	A1-5C to A2-6A	A2-4F to A2-8F*
A1-9A to A2-2E	A1-6C to A2-6B	
A1-10A to A2-2A	A1-7C to A2-6C	

e. Connect the following jacks with resistance patch-cords, disregarding color-coded leads unless noted:

(1) A1-8E to A2-4I with 3088-4 patch-cord. Turn potentiometer of patch-cord a minimum of 3 full turns counterclockwise. Adjusting potentiometer provides sufficient resistance to prevent a short if VERTICAL ground strap has not been removed or inadvertently makes contact with mating post.

(2) A1-7E to A2-4E with 3088-5 patch-cord.

(3) A2-8E to A2-4F and A2-8F with 3088-6 patch-cord. Connect yellow lead to A2-8E.

(4) A2-6G to A2-6H, A2-6I, and A2-6J with 3088-1 patch-cord. Connect red lead to A2-6G, black lead to A2-6I, yellow lead to A2-6H, and blue lead to A2-6J.

f. Ensure that patch-cords installed in steps d and e are connected to proper jacks, then close ELECTRICAL CONTROL panel.

g. Momentarily depress ON-STANDBY switch-light. ON light comes on and STANDBY light goes off.

h. Momentarily depress SELECT switch-lights 1 and 2 on ELECTRICAL CONTROL panel. Upper lights 1 and 2 come on.

i. Turn MONITOR, VOLTS RANGE SELECT switch to position C (0-75) range.

j. Depress and hold TEST OPERATE switch. VOLTS meter indicates a maximum of 2 volts. Rotate VOLTAGE ADJUST knob to maximum INCREASE position, note voltage indication on VOLTS meter, and rotate VOLTAGE ADJUST knob to DECREASE until VOLTS meter indicates 25 ±3 volts. VOLTS meter must indicate a minimum of 30 volts when VOLTAGE ADJUST knob is to maximum INCREASE position.

k. Release TEST OPERATE switch. VOLTS meter indicates zero.

l. Turn RANGE SELECT knob to position D (0-30).

m. Depress and hold TEST OPERATE switch and rotate VOLTAGE ADJUST knob until VOLTS meter indicates 28 ±0.5 vdc. Release TEST OPERATE switch. VOLTS meter indicates zero.

n. Momentarily depress SELECT switch-lights 1 and 2. Upper lights 1 and 2. go off.

o. Turn CHANNEL SELECT switch on PRESSURE/TEMPERATURE MONITOR panel to 2.

p. Observe temperature indicator and apply a source of heat or cold to low-flow temperature transducer. Low-flow transducer can be identified by P15 connector connected to it.) Temperature meter must indicate an increase or decrease in indicated temperature. An acceptable method of applying heat is to enfold with both hands the housing in which the transducer is installed. A temperature increase of 10° or more can thus be obtained.

q. Turn CHANNEL SELECT switch on PRESSURE/TEMPERATURE MONITOR panel to 3.

r. Repeat step p on high-flow temperature transducer. (High-flow transducer can be identified by P18 connector connected to it).

s. Turn CHANNEL SELECT switch to OFF.

t. Depress CIRCUIT BREAKER on test cell utility panel.

u. Move LIGHTS TEST CELL switch on test cell utility panel to ON and then to OFF. Test cell lights come on and go off.

*v. Using multimeter, set to a range capable of indicating 120vac. Verify and record voltage at 120-240 facility outlet.

*w. Using multimeter, measure voltages at each of the following sockets of the 3 receptacles on test cell utility panel: (Voltages obtained in substeps 1 and 2 must be within 2 volts of each other and the voltage recorded in step v. Voltage obtained in substep 3 must be one volt maximum.)

(1) Phase to neutral.

(2) Phase to safety ground.

(3) Neutral to safety ground.

NOTE

The safety ground socket is the D-shaped socket. When the receptacle is installed with the safety ground socket located above the 2 slotted sockets (when facing the receptacle), the phase socket is on the left and the neutral socket is on the right.

*x. Using multimeter, measure voltages at outlets 602A, 602B, 603A, 603B, 604A, 604B, 605A, and 605B. (Voltages obtained in substeps 1 and 2 must be within 2 volts of each outlet and the voltage recorded in step v. Voltage obtained in substep 3 must be one volt maximum.)

(1) Phase to neutral.

(2) Phase to safety ground.

(3) Neutral to safety ground.

y. Ensure that ground strap is removed from middle jack of VERTICAL test jack on front of oscilloscope, then depress 1 AMP circuit breaker on P.U. VALVE POSITION CONTROLLER panel.

CAUTION

If ground strap is not removed, damage to amplifier in propellant utilization panel can result.

z. Ensure that valve position switch is to VALVE OPENING position.

aa. Move toggle switch below AC POWER ON light to upper position, AC POWER ON light comes on and VALVE OPENING meter indicates 60-70 percent.

NOTE

Steps ab through ar are performed on the ELECTRICAL CONTROL panel.

ab. Position voltmeter RANGE SELECT switch to A(0-150 AC).

ac. Momentarily depress SELECT switch-lights 7 and 8. Upper lights 7 and 8 come on.

ad. Depress and hold OPERATE switch. VOLTS meter indicates 40-70 volts. Release OPERATE switch. VOLTS meter indicates zero.

ae. Momentarily depress SELECT switch-light 8. Upper light 8 goes off.

af. Depress and hold OPERATE switch. VOLTS meter indicates 20-35 volts. Release OPERATE switch. VOLTS meter indicates zero.

ag. Momentarily depress SELECT switch-light 7. Upper light 7 goes off.

ah. Momentarily depress SELECT switch-lights 4 and 8. Upper lights 4 and 8 come on.

ai. Depress and hold OPERATE switch. VOLTS meter indicates 20-35 volts. Release OPERATE switch. VOLTS meter indicates zero.

aj. Momentarily depress SELECT switch-lights 4 and 8. Upper lights 4 and 8 go off.

ak. Momentarily depress SELECT switch-lights 5 and 6. Upper lights 5 and 6 come on.

al. Depress and hold OPERATE switch. VOLTS meter indicates 50-75 volts. Release OPERATE switch. VOLTS meter indicates zero.

am. Momentarily depress SELECT switch-light 6. Upper light 6 goes off.

an. Momentarily depress SELECT switch-light 3. Upper light 3 comes on.

ao. Depress and hold OPERATE switch. VOLTS meter indicates 50-75 volts. Release OPERATE switch. VOLTS meter indicates zero.

ap. Momentarily depress SELECT switch-light 5. Upper lights 5 goes off.

aq. Momentarily depress SELECT switch-lights 4 and 6. Upper lights 4 and 6 come on.

ar. Depress and hold OPERATE switch. VOLTS meter indicates 0 (+2, -0) volts. Release OPERATE switch. VOLTS meter indicates zero.

NOTE

Steps as through ax are performed on the P. U. VALVE POSITION CONTROLLER panel.

as. Move valve position switch to NOMINAL VALVE OPENING. VALVE OPENING meter indicates 30-40 percent.

at. Move valve position switch to VALVE OPENING. VALVE OPENING meter indicates 60-70 percent.

au. Move switch below AC POWER ON light to OFF. VALVE OPENING meter indicates zero and AC POWER ON light goes off.

av. Move switch below AC POWER ON light to upper position. VALVE OPENING meter indicates 60-70 percent and AC POWER ON light comes on.

aw. On P. U. VALVE POSITION CONTROLLER panel terminal board, measure input voltage between TB1-2 and chassis ground. Voltage reading is 115 ±5 vac and above ground. (Terminal board is accessible from rear of console after STORAGE drawer is pulled out.)

ax. Measure input voltage between TB1-9 and chassis ground. Voltage reading is zero.

ay. Push in STORAGE drawer.

az. Adjust oscilloscope as follows:

(1) HORIZONTAL AC-DC switch to AC.

(2) VERTICAL AC-DC switch to DC.

(3) VERTICAL SENSITIVITY (black knob) to MILLIVOLTS/CM at 10.

(4) VERTICAL VERNIER (red knob) to full counterclockwise position.

(5) TRIGGER SOURCE (black knob) to INT. - (negative) position.

(6) TRIGGER LEVEL (red knob) to AUTO position.

(7) HORIZONTAL DISPLAY (black knob) to EXT. SENSITIVITY VOLTS/CM at 10.

(8) HORIZONTAL VERNIER (red knob) to SWEEP TIME μ SEC/CM at 50.

ba. Turn INTENSITY & POWER switch clockwise to mid-position. Pilot light comes on and a signal trace pattern appears. If pattern does not appear, depress BEAM FINDER and center beam by use of VERTICAL and HORIZONTAL POSITION knob. Release BEAM FINDER.

bb. Adjust VERTICAL and HORIZONTAL POSITION knobs to center pattern on scope and INTENSITY & POWER switch to obtain sharpest pattern trace.

NOTE

Steps bc and bd demonstrate polarity, nulling, and reversing capabilities of the amplifier.

bc. Pull out ELECTRICAL CONTROL panel and adjust potentiometer of resistance patch-cord 3088-4 to obtain a pattern without crossovers. Pattern may be of any shape; however, it must lie generally in second and fourth quadrants. Quadrants are numbered in a counterclockwise direction with first quadrant in upper right-hand corner.

bd. Slowly rotate VALVE POSITION INPUT REFERENCE COARSE ADJT on P.U. VALVE POSITION CONTROLLER panel clockwise until signal trace pattern changes to a position generally in first and third quadrants. Phase shift must be complete when VALVE POSITION INPUT REFERENCE COARSE ADJT is between 350 and 370.

be. Move INTENSITY & POWER switch to OFF. Pilot light goes off and pattern disappears from oscilloscope. Connect grounding strap to middle post (red) of vertical posts on front of oscilloscope.

bf. Ensure that liquid level gage, located at end of hydraulic pump reservoir, indicates a liquid level. If liquid is not observed in sight gage, fill reservoir. Refer to paragraph 12-55 for filling.

bg. Unlock test cell cover by moving lever to left.

bh. Open test cell cover by simultaneously depressing then releasing both OPEN TEST CELL buttons on test cell utility panel. Test cell cover opens and automatically stops when fully open. Cover is fully open when a clearance of 0.025 to 0.040 inch is reached at any point between any one of test cell cover

hinges and stop pads. If doubt exists as to correct adjustment of cover open switch, operator must be prepared to stop cover by depressing and holding one CLOSE TEST CELL button.

bi. Check for minimum clearance of 0.025 to 0.040 inch between test cell cover hinge and stop pad at any point. If clearance is not met, refer to paragraph 12-69 for adjustment.

bj. Depress and hold both CLOSE TEST CELL buttons until test cell cover is fully closed.

bk. Warm hydraulic oil by opening and closing test cell cover several times before continuing test.

bl. Open test cell cover by simultaneously depressing then releasing both OPEN TEST CELL buttons. Test cell cover operates smoothly and is fully open within 25-40 seconds. If test cell cover does not operate within described time limits, refer to paragraph 12-63 for adjustment.

bm. Inspect hydraulic system for evidence of fluid leakage. Hydraulic system must be free of leakage, as indicated by a lack of fluid at pressurized connections.

bn. Depress left-hand CLOSE TEST CELL button. Test cell cover must not move. Release button.

bo. Depress right-hand CLOSE TEST CELL button. Test cell cover must not move. Release button.

bp. Depress both CLOSE TEST CELL buttons. Before cover is fully closed, release buttons. Test cover must automatically move to fully open position.

bq. Depress both CLOSE TEST CELL buttons until cover is fully closed. Cover must remain fully closed. Release buttons.

br. Depress left-hand OPEN TEST CELL button. Cover must remain closed. Release button.

bs. Depress right-hand OPEN TEST CELL button. Cover must remain closed. Release button.

bt. Prepare console for pneumatic use, but do not supply facility gaseous nitrogen to console (paragraph 12-34). A minimum of 6,750 psig of helium pressure is required for this test unless the 6,400 psig relief valves have been previously tested, in which case the minimum required pressure is 5,000 psig.

bu. Vent trapped pressure in console by opening SYST VENT valve on SYSTEM SUPPLY panel, then close SYST VENT valve.

bv. Unlock and open test cell cover.

bw. Obtain necessary fittings, packings, and hoses from components adapter set 9016796 and interconnect pneumatic outlets in test cell as follows:

NOTE

Adapters installed in pneumatic outlets must be replaced with appropriate AN-type fittings to permit connection of hoses. Unless specified, sizes of hoses are optional.

(1) PNEU. OUTLET MED PRESS to 0-2000 PSIG MON INLET and to 0-1000 PSIG MON INLET.

(2) PNEU OUTLET HIGH PRESS to 0-6000 PSIG MON INLET and to each of the 0-600 PSIG UTILITY INLETS, with hoses R24525-4-0480.

(3) Install cryogenic hand valves 19-9021936 on tee on liquid nitrogen standpipe and on LN_2 RETURN port. If a 3/4-inch hose is installed between these ports, remove and cap it. Do not remove 1/4-inch hose. Leave 3/4-inch hose in test cell, since it is used later in test. Position valves so that they do not interfere with test cell cover when cover is closed.

(4) Ensure that cryogenic hand valves are closed.

bx. Close and lock test cell cover.

by. Check for zero leakage past the HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel by observing SYST SUPPLY PRESS gage on SYSTEM SUPPLY panel for increasing pressure.

NOTE

Steps bz through cg check the opening pressures of the 6,400 psig relief valves. If these valves were tested prior to beginning this test, proceed to step ch.

bz. Ensure that facility helium supply to console is less than 6,000 psig.

ca. Open HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Facility pressure is indicated on SYST SUPPLY PRESS gage on SYSTEM SUPPLY panel.

cb. Caution personnel in immediate vicinity of console of impending venting of high-pressure gases.

WARNING

Venting of high-pressure gases can startle personnel, resulting in injury to personnel and damage to equipment.

cc. Slowly increase helium pressure to console until 6,400 psig relief valve in pneumatic source system opens, then reduce pressure. Valve opens between 6,080 and 6,720 psig. Monitor opening pressure on facility gage having a minimum accuracy of one percent. If valve does not open within tolerance, refer to paragraph 12-65 for adjustment.

cd. Close HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

ce. Ensure that facility helium supply to console is less than 6,000 psig, then open SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

cf. Repeat steps cb and cc for 6,400 psig valve in LN_2 tank pressure system.

cg. Close SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

ch. Open HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Helium pressure is indicated on SYST SUPPLY PRESS gage on SYSTEM SUPPLY panel.

ci. Open NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

cj. Check for zero reverse leakage of check valve which isolates helium source pressure from nitrogen source supply by observing nitrogen SOURCE PRESSURE gage for pressure increase.

ck. Check for zero leakage past SOURCE SHUTOFF VALVE on LN_2 TANK PRESSURE panel by turning and holding PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE, while observing REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel for an indication of increasing pressure.

cl. Open SOURCE SHUTOFF VALVE on LN_2 TANK PRESSURE panel.

cm. Vent pressure, indicated by any REG SUPPLY PRESS gage, by opening SHUTOFF and VENT valves on associated panel until gage returns to zero. Close SHUTOFF and VENT valves. On LN_2 TANK PRESSURE panel, turn PRESSURE REGULATOR to DECREASE to vent any indicated pressure.

cn. Check for zero leakage past the PRESSURE REGULATOR on each of the following by observing REG SUPPLY PRESS gages for pressure increase.

(1) HIGH PRESSURE panel.

(2) MEDIUM PRESSURE panel.

(3) LOW PRESSURE panel.

(4) LN_2 TANK PRESSURE panel.

co. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE until a minimum of 100 psi is indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel.

cp. Open SHUTOFF valve on HIGH PRESSURE panel. Slowly build up pressure as indicated on PRESSURE GAGE on PRESSURE/TEMPERATURE MONITOR panel until SYSTEM PRESSURIZED light comes on, then close SHUTOFF valve. Light comes on between 25 and 75 psi. If light does not come on within tolerance, refer to paragraph 12-67 for adjustment.

cq. Open VENT valve on HIGH PRESSURE panel until SYSTEM PRESSURIZED light goes off, then close VENT valve. SYSTEM PRESSURIZED light goes off before zero is reached, as indicated on PRESSURE gage on PRESSURE/TEMPERATURE MONITOR panel.

cr. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE until a minimum of 100 psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel.

cs. Slowly open SHUTOFF valve on MEDIUM PRESSURE panel. Build up pressure as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE ΔP MONITOR panel until SYSTEM PRESSURIZED light comes on, then close SHUTOFF valve. Light comes on between 25 and 75 psi. If light does not come on within tolerance, refer to paragraph 12-67 for adjustment.

ct. Open VENT valve on MEDIUM PRESSURE panel until SYSTEM PRESSURIZED light goes off, then close VENT valve. SYSTEM PRESSURIZED light goes off before zero is reached, as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

cu. Open SHUTOFF valve on LOW PRESSURE panel.

cv. Turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE until SYSTEM PRESSURIZED light comes on. Light comes on between 25 and 75 psi as indicated on REG SUPPLY PRESS gage on LOW PRESSURE panel.

cw. Turn PRESSURE REGULATOR on LOW PRESSURE panel to DECREASE until SYSTEM PRESSURIZED light goes off. Light goes off before zero is reached.

cx. Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

cy. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 20-25 psi is indicated on REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel. Wait one minute to permit system pressure to stabilize, then verify that SYSTEM PRESSURIZED light has not come on.

cz. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 70-75 psi is indicated on REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel. SYSTEM PRESSURIZED light comes on. A short wait may be necessary to permit system pressure to stabilize before light comes on.

da. Depress PRESS TO VENT TANK switch light and turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE for a minimum of 5 seconds. PRESS TO VENT TANK light comes on and system vents. Continue venting system for a minimum of 15 seconds after SYSTEM PRESSURIZED light has gone out, then depress PRESS TO VENT TANK switch light. PRESS TO VENT TANK light goes off.

NOTE

Venting is maintained after SYSTEM PRESSURIZED light goes off to effect a sufficient decrease in pressure to ensure that SYSTEM PRESSURIZED light will not come on when system pressure stabilizes. If SYSTEM PRESSURIZED light does come on, repeat step da.

db. Disconnect lines to LN_2 RETURN, LN_2 SUPPLY, and LN_2 VENT outlets at rear of test cell.

dc. Open SHUTOFF valves on MEDIUM PRESSURE and HIGH PRESSURE panels. SYSTEM PRESSURIZED light comes on.

dd. While listening for audible leakage, turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure until 4,900 to 5,000 psi is indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel and on gage on PRESSURE/TEMPERATURE MONITOR panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

de. While listening for audible leakage, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure until 1,970 to 1,985 psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel

and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

df. While listening for audible leakage, turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE. Slowly build up pressure until 150-155 psi is indicated on REG SUPPLY PRESS gage on LOW PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

dg. Check for zero leakage past VENT valve on PRESSURE/ΔP MONITOR panel by applying leak-test compound over LN_2 VENT outlet at rear of console. Ensure that leak-test compound does not enter LN_2 VENT outlet.

dh. While listening for audible leakage, turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Slowly build up pressure until 1,185 to 1,215 psi is indicated on REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

di. Check for zero leakage past the LN_2 tank vent valve, LN_2 tank vent solenoid valve, and relief valve by applying leak-test compound over LN_2 VENT outlet at rear of console. If leakage exists, disassemble internal plumbing and determine which of the 3 components is faulty.

dj. Check for zero leakage past LN_2 return valve by applying leak-test compound over LN_2 RETURN outlet on rear of console. Ensure that leak-test compound does not enter LN_2 RETURN outlet.

dk. Check for zero reverse leakage from LN_2 supply system check valve by applying leak-test compound over LN_2 SUPPLY outlet on rear of console. Ensure that leak-test compound does not enter LN_2 SUPPLY outlet.

dl. Install a pressure cap over LN_2 RETURN outlet on rear of console.

dm. Open LN_2 return and LN_2 supply valves.

dn. Apply leak-test compound to all tubing connections and vent valve and relief valve outlets on the following panels. Also check tubing connections on interconnecting lines between any 2 of the following panels. No leakage is allowable. If leakage exists on tubing connections, vent pressure and correct leakage before proceeding with test.

(1) PNEU SOURCE CONTROL panel.

(2) SYSTEM SUPPLY panel.

(3) HIGH PRESSURE panel.

(4) MEDIUM PRESSURE panel.

(5) LOW PRESSURE panel.

(6) LN_2 TANK PRESSURE panel.

(7) PRESSURE/TEMPERATURE MONITOR panel.

(8) TEST CELL MONITOR PRESSURE gage.

(9) 0-6000 PSIG UTILITY INLETS.

(10) LN_2 system under test cell.

do. Check for zero leakage past PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel by observing gage on PRESSURE/FLOW MONITOR panel for pressure increase.

dp. Move PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until 960-980 psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel and on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

dq. Open all valves on PRESSURE/FLOW MONITOR panel. Gage on PRESSURE/FLOW MONITOR panel indicates 960-980 psi.

dr. Apply leak-test compound to all tubing connections and relief valve outlets on PRESSURE/FLOW MONITOR panel. No leakage is allowable. If leakage exists on tubing connections, vent pressure and correct leakage before proceeding with test. Correction of minor leakage from relief valve outlets may be delayed until completion of test.

ds. Close LN_2 supply valve inside console and below test cell.

dt. Increase pressure in LN_2 system in 25-psi increments by turning PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Wait one minute between each 25 psi increase to allow system pressure to stabilize. Continue increasing pressure until relief valve opens. Relief valve opens between 1,275 and 1,375 psi, as indicated on REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel.

du. Close LN_2 TANK SHUTOFF and SOURCE SHUTOFF valves on LN_2 TANK PRESSURE panel.

dv. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE until associated REG SUPPLY PRESS gage indicates zero.

dw. Check for zero leakage past LN_2 TANK SHUTOFF valve by checking vent outlet of PRESSURE REGULATOR on LN_2 TANK PRESSURE panel for evidence of leakage.

dx. Depress PRESS TO VENT TANK switch light on LN_2 TANK PRESSURE panel. PRESS TO VENT TANK light comes on.

dy. Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

dz. Close SHUTOFF valve on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels.

ea. Open VENT valves on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels.

eb. When SYSTEM PRESSURIZED light goes off, wait a minimum of 15 seconds then depress PRESS TO VENT TANK switch light on LN_2 TANK PRESSURE panel. PRESS TO VENT TANK light goes off.

ec. Check for zero leakage past SHUTOFF valve on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels by applying leak-test compound to the outlet ports of the VENT valves.

ed. Close LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

ee. Open SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

ef. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 1,185 to 1,215 psi is indicated on associated REG SUPPLY PRESS gage.

eg. Close gage isolation valves inside console and accessible through the right-hand access door, for the following panels:

(1) HIGH PRESSURE panel.

(2) MEDIUM PRESSURE panel.

(3) LOW PRESSURE panel.

(4) LN_2 TANK PRESSURE panel.

eh. Turn PRESSURE REGULATOR on the following panels to DECREASE until all audible venting of pressure has ceased, then release PRESSURE REGULATOR:

(1) HIGH PRESSURE panel.

(2) MEDIUM PRESSURE panel.

(3) LOW PRESSURE panel.

(4) LN_2 TANK PRESSURE panel.

ei. Check for zero leakage past gage isolation valves by observing REG SUPPLY PRESS gages on the following panels for pressure decrease:

(1) HIGH PRESSURE panel.

(2) MEDIUM PRESSURE panel.

(3) LOW PRESSURE panel.

(4) LN_2 TANK PRESSURE panel.

ej. Open the 4 closed gage isolation valves.

ek. Unlock and open test cell cover.

el. Disassemble existing test setup and reconnect as necessary to accomplish the following: (Do not remove cryogenic hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to 0-1000 PSIG MON INLET, DNSTM INLET 0-60 Δ P, and UPSTM INLET 0-60 Δ P.

(2) PNEU OUTLET MED PRESS connected to 0-600 PSIG MON "A" INLET and 0-600 PSIG MON "B" INLET outlets. (To prevent interference with test cell cover when cover is in closed position, use an elbow fitting in 0-600 PSIG MON "B" INLET.)

em. Close and lock test cell cover.

en. Close all valves on PRESSURE/FLOW MONITOR panel.

eo. Close VENT valves on HIGH PRESSURE and MEDIUM PRESSURE panels.

ep. Open SHUTOFF valves on HIGH PRESSURE and MEDIUM PRESSURE panels.

eq. While listening for audible leakage, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure until 560-590

psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel and on PRESSURE MONITOR "A" and PRESSURE MONITOR "B" gages on LOW PRESSURE MONITOR panel. SYSTEM PRESSURIZED light comes on. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

er. While listening for audible leakage, turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure until 2,950 to 3,000 psi is indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

es. Apply leak-test compound to all tubing connections, vent valve, and relief valve outlets on LOW PRESSURE MONITOR panel and PRESSURE DIFFERENTIAL system on PRESSURE/ΔP MONITOR panel. No leakage is allowable. If leakage exists on tubing fittings, vent pressure and correct leakage before proceeding with test. Correction of minor leakage from vent or relief valve outlets may be delayed until completion of test.

et. Turn PRESSURE REGULATORS on MEDIUM and HIGH PRESSURE panels to DECREASE and vent pressures downstream of these regulators. SYSTEM PRESSURIZED light goes off and MEDIUM and HIGH PRESSURE gages and MONITOR "A" and "B" gages on LOW PRESSURE MONITOR panel indicate zero.

eu. Turn off facility helium supply.

ev. Open SYST VENT valve on SYSTEM SUPPLY panel until SYST SUPPLY PRESS gage indicates zero. Close valve.

ew. Close NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

ex. Turn on facility gaseous nitrogen supply. Facility gaseous nitrogen pressure is indicated on nitrogen SOURCE PRESS gage on PNEU SOURCE CONTROL panel. A minimum of 5,000 psi nitrogen pressure is required.

ey. Check for zero leakage past NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel by observing SYST SUPPLY PRESS gage on SYSTEM SUPPLY panel for pressure increase.

ez. Open NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Facility pressure is indicated on SYST SUPPLY PRESS gage.

fa. Check for zero reverse leakage of check valve which isolates nitrogen source pressure from helium supply system by observing helium SOURCE PRESS gage on PNEU SOURCE CONTROL panel for pressure increase.

fb. Close HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

fc. Open PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel.

fd. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel until 1,050 psig relief valve on PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 998 to 1,102 psig. When relief valve opens, turn PRESSURE REGULATOR to DECREASE and vent all pressure indicated on HIGH PRESSURE and PRESSURE/FLOW MONITOR panels. REG SUPPLY PRESS gage on HIGH PRESSURE panel and pressure gage on PRESSURE/FLOW MONITOR panel indicate zero, SYSTEM PRESSURIZED light goes off, and relief valve closes.

fe. Move power switch on DIGITAL VOLTMETER to ON.

NOTE

DIGITAL VOLTMETER is energized and is being warmed up for use later on.

ff. Unlock and open test cell door.

fg. Reconnect test setup as necessary to accomplish the following: (Do not remove hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to 0-2000 PSIG MON INLET and 0-6000 PSIG MON INLET.

(2) PNEU OUTLET MED PRESS connected to HIGH FLOW INLET.

(3) PNEU OUTLET LOW PRESS connected to 0-600 PSIG MON "A" INLET.

(4) HIGH FLOW OUTLET connected to 0-600 PSIG MON "B" INLET.

fh. Close and lock test cell cover.

fi. Close PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel.

fj. Open SHUTOFF valve on LOW PRESSURE panel.

fk. Close VENT valve on LOW PRESSURE panel.

fl. Close gage isolation valve, inside console, for REG SUPPLY PRESS gage on LOW PRESSURE panel.

fm. Turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE. Slowly build up pressure as indicated on PRESSURE MONITOR "A" gage or LOW PRESSURE MONITOR panel until 170 psig relief valve on LOW PRESSURE panel opens. SYSTEM PRESSURED light comes on. Relief valve opens at 162-178 psig. When relief valve opens, turn PRESSURE REGULATOR on LOW PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

fn. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel until 1,100 psig relief valve in high-flow system of PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 1,045 to 1,155 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

fo. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel as necessary until 950 to 1,000 psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel.

fp. Check for zero leakage past SHUTOFF valve between HIGH FLOW SHUTOFF and PRESSURE MONITOR INLET valves on PRESSURE/FLOW MONITOR panel by observing pressure gage on PRESSURE/FLOW MONITOR panel for pressure increase.

fq. Check for zero leakage past HIGH FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel by observing PRESSURE MONITOR "B" gage on LOW PRESSURE MONITOR panel for pressure increase.

fr. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on PRESSURE gage on PRESSURE/TEMPERATURE MONITOR panel until 2,100 psig relief valve in TEST CELL MONITOR PRESSURE system opens. TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel also indicates pressure and may go beyond range which is not detrimental to gage. Relief valve opens at 1,995 to 2,205 psig. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

fs. Prepare DIGITAL VOLTMETER for frequency measurements. (Refer to paragraph 12-30.) DIGITAL VOLTMETER has been turned on. If it is at operating temperature, the warm-up period required by adjustment procedure may be ignored. Frequency measurement cannot be obtained until step fu is performed.

ft. Open LOW PRESSURE MONITOR "B" VENT valve on LOW PRESSURE MONITOR panel.

fu. Check operation of high-flow transducer by slowly opening HIGH FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel until a minimum of 000.100 cps is indicated on DIGITAL VOLTMETER. Close HIGH FLOW SHUTOFF valve.

fv. Close LOW PRESSURE MONITOR "B" VENT valve on LOW PRESSURE MONITOR panel.

fw. Move PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until a maximum of 500 psi is indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel.

fx. Open HIGH FLOW SHUTOFF valve and SHUTOFF valve between PRESSURE MONITOR INLET and HIGH FLOW SHUTOFF valves on PRESSURE/FLOW MONITOR panel. Pressure gage on PRESSURE/FLOW MONITOR panel and MONITOR "B" pressure gage on LOW PRESSURE MONITOR panel indicate a maximum of 500 psi.

fy. Close gage isolation valve, inside console, for MONITOR "B" gage on LOW PRESSURE MONITOR panel.

fz. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE and slowly build up pressure as indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel and pressure gage on PRESSURE/FLOW MONITOR panel until 630 psig relief valve in MONITOR "B" system in LOW PRESSURE MONITOR panel opens. Relief valve opens at 598-662 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

ga. Turn PRESSURE REGULATOR on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels to DECREASE to vent all pressure. SYSTEM PRESSURIZED light goes off. MONITOR "B" pressure gage indicates pressure locked in by closed gage isolation valve.

gb. Check for zero leakage past gage isolation valve for MONITOR "B" gage by observing MONITOR "B" gage for pressure decrease.

gc. Open gage isolation valve for MONITOR "B" gage. MONITOR "B" gage pressure decreases to zero.

gd. Unlock and open test cell cover.

ge. Reconnect test setup as necessary to accomplish the following: (Do not remove hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to LOW FLOW INLET and to 0-2000 PSIG MON INLET.

(2) LOW FLOW OUTLET connected to 0-600 PSIG MON "A" INLET.

(3) PNEU OUTLET MEDIUM PRESS connected to 0-6000 PSIG MON INLET.

gf. Close and lock test cell cover.

gg. Close gage isolation valve for REG SUPPLY PRESS gage on MEDIUM PRESSURE panel.

gh. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on PRESSURE/TEMPERATURE MONITOR panel until 2,100 psig relief valve in MEDIUM PRESSURE panel opens. SYSTEM PRESSURIZED light comes on. Relief valve opens at 1,995 to 2,205 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

gi. Close the 2 opened valves on PRESSURE/FLOW MONITOR panel. All 5 valves on this panel are now closed.

gj. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel until 1,100 psig relief valve in low-flow system of PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 1,045 to 1,155 psig. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until relief valve closes, then release PRESSURE REGULATOR.

gk. Turn PRESSURE REGULATOR on HIGH PRESSURE panel as necessary to obtain 950 to 1,000 psi as indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

gl. Check for zero leakage past SHUTOFF valve between LOW FLOW SHUTOFF and PRESSURE MONITOR INLET valves on PRESSURE/FLOW MONITOR panel by observing pressure gage on PRESSURE/FLOW MONITOR panel for pressure increase.

gm. Check for zero leakage past LOW FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR by observing PRESSURE MONITOR "A" gage on LOW PRESSURE MONITOR panel for pressure increase.

gn. Momentarily depress ON-STANDBY switch-light on ELECTRICAL CONTROL panel. STANDBY light comes on and ON light goes off.

go. Open ELECTRICAL CONTROL panel, remove patch-cord lead from A2-10E, and reconnect it to A2-10C.

gp. Remove patch-cord lead from A2-10F, reconnect it to A2-10D, and close ELECTRICAL CONTROL panel.

gq. Momentarily depress ON-STANDBY switch-light on ELECTRICAL CONTROL panel. On light comes on and STANDBY light goes off.

gr. Open LOW PRESSURE MONITOR "A" VENT valve on LOW PRESSURE MONITOR panel.

gs. Check operation of low-flow transducer by slowly opening LOW FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel until 001.000 kilocycle is indicated on DIGITAL VOLTMETER. Close LOW FLOW SHUTOFF valve. Move toggle switch on DIGITAL VOLTMETER down. DIGITAL VOLTMETER is deenergized.

gt. Close LOW PRESSURE MONITOR "A" VENT valve on LOW PRESSURE MONITOR panel.

gu. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until 575-600 psi is indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

gv. Open LOW FLOW SHUTOFF valve and SHUTOFF valve between PRESSURE MONITOR INLET and LOW FLOW SHUTOFF valves on PRESSURE/FLOW MONITOR panel. Pressure gage on PRESSURE/FLOW MONITOR panel and MONITOR "A" pressure gage on LOW PRESSURE MONITOR panel indicate 575-600 psi.

gw. Close gage isolation valve, inside console, for MONITOR "A" gage on LOW PRESSURE MONITOR panel.

gx. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on HIGH PRESSURE panel, TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel, and gage on PRESSURE/FLOW MONITOR panel until 630 psig relief valve in MONITOR "A" system in LOW PRESSURE MONITOR panel opens. Relief valve opens at 598-662 psig. Opening pressure is monitored on gage in PRESSURE/FLOW MONITOR panel. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE and vent pressure as indicated by TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel and gage on PRESSURE/FLOW MONITOR panel.

gy. Check for zero leakage past gage isolation valve for MONITOR "A" gage by observing MONITOR "A" gage for pressure decrease.

gz. Open gage isolation valve for MONITOR "A" gage. MONITOR "A" gage pressure decreases to zero.

ha. Open gage isolation valve, inside console, for REG SUPPLY PRESS gage on MEDIUM PRESSURE panel. Gage indicates approximately same pressure as indicated on PRESSURE/TEMPERATURE MONITOR panel.

hb. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE. Vent pressure as indicated on gage on PRESSURE/TEMPERATURE MONITOR panel and REG SUPPLY PRESS gage on MEDIUM PRESSURE panel. SYSTEM PRESSURIZED light goes out.

hc. Unlock and open test cell cover.

hd. Disassemble test setup and reconnect as necessary to accomplish the following:

(1) Cryogenic hand valve on LN_2 standpipe connected to 0-2000 PSIG MON INLET. (Use hose left in test cell (step bw) and a second cryogenic hose to effect hook-up.)

(2) LN_2 RETURN in test cell connected to 0-600 PSIG MON "A" INLET.

(3) PNEU OUTLET MED PRESS connected to LN_2 SUPPLY and LN_2 RETURN outlets at rear of console. (To permit closing test cell cover, utilize 0-6000 PSIG UTILITY INLETS to supply pressure to outlets at rear of console.)

he. Close LN_2 return valve inside console and below test cell.

hf. Close and lock test cell cover.

hg. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel until 1,325 psig relief valve in LN_2 supply system opens. Relief valve opens at 1,259 to 1,391 psi, as indicated on gage on MEDIUM PRESSURE panel. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes.

hh. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel as necessary to obtain 1,150 to 1,200 psi as indicated on gage on MEDIUM PRESSURE panel.

hi. Check for zero reverse leakage of check valve in LN_2 return system by observing MONITOR "A" gage on LOW PRESSURE MONITOR panel for pressure increase.

hj. Wait 10 minutes, then check for zero leakage past LN_2 SUPPLY valve by observing TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel for pressure increase.

NOTE

The waiting period is necessary due to the large volume of liquid nitrogen in the storage tank.

hk. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE and vent pressure indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel.

hl. Vent trapped pressure upstream of check valve in LN_2 supply line by opening LN_2 SUPPLY and LN_2 tank vent valves inside console and below test cell.

hm. Unlock and open test cell cover.

hn. Disconnect and remove test setup including connections to rear of console, but do not remove connection between LN_2 standpipe and 0-2000 PSIG MON INLET.

ho. Close and lock test cell cover.

hp. Open VENT valve on PRESSURE/ΔP MONITOR panel.

hq. Connect facility lines to LN_2 SUPPLY and LN_2 RETURN connections on rear of console.

hr. Supply facility helium pressure to console. Facility pressure is indicated on helium SOURCE PRESS gage on PNEU SOURCE CONTROL panel. A minimum of 1,400 psig is required for this test.

hs. Open hand valve connected to tee at top of LN_2 storage tank.

ht. Supply facility liquid nitrogen to console and fill storage tank until 15-18 inches is indicated on LN_2 LEVEL gage. When required level is reached, close LN_2 SUPPLY and LN_2 tank vent valves, inside console and below test cell, and VENT valve on PRESSURE/ΔP MONITOR panel.

WARNING

Do not allow any part of the body to come in contact with frozen or extremely cold material. Human tissue will freeze upon contact, causing serious permanent injury.

hu. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until REG SUPPLY PRESS gage indicates 1,200 ±40 psi.

hv. Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

hw. Inspect liquid nitrogen tank system connections for leakage. No audible leakage is allowable.

hx. If leakage is found at line connections or relief valve requires adjustment, drain LN_2 storage tank, depressurize pneumatic system, and allow system to return to ambient temperature before tightening connections or adjusting relief valve.

WARNING

Loosening or tightening connections while system is pressurized or at cryogenic temperature can result in serious injury to personnel and damage to equipment.

hy. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on LN_2 TANK PRESSURE panel and on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel until 1,325 psig relief valve in LN_2 system opens. Relief valve opens at 1,259 to 1,391 psi, as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel. When relief valve opens, turn PRESSURE REGULATOR on LN_2 PRESSURE PANEL to DECREASE until relief valve closes, then release regulator.

hz. Dispose of liquid nitrogen remaining in LN_2 storage tank (approximately 2 gallons for each inch shown on LN_2 LEVEL gage) either by returning it to facility supply or venting it to atmosphere. To return liquid nitrogen to facility supply, perform steps ia through ic. To vent it to atmosphere, proceed to step id.

ia. Prepare facility to accept return of liquid nitrogen.

ib. Open LN_2 return valve inside console and below test cell.

ic. Increase pressure in LN_2 system to overcome facility supply pressure. Pressure increase can be accomplished by natural boiloff of liquid or by turning PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until required pressure is reached. Monitor LN_2 system pressure on TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel. When liquid has been depleted as indicated on LN_2 LEVEL gage, close LN_2 return valve.

id. Open LN_2 tank vent valve inside console and below test cell.

ie. Close SOURCE SHUTOFF and LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

if. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE until REG SUPPLY PRESS gage on LN_2 TANK PRESSURE panel indicates zero, then release regulator.

ig. Close NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

ih. Open SYST VENT valve on SYSTEM SUPPLY panel.

ij. Close SHUTOFF valves on LOW PRESSURE, MEDIUM PRESSURE, and HIGH PRESSURE panels.

ik. Open all closed gage isolation valves.

il. Close opened valves on PRESSURE FLOW MONITOR panel.

im. Close facility nitrogen and helium pressure supplies. Nitrogen and helium SOURCE PRESS gages indicate zero.

in. When all pressure has been vented and SYSTEM PRESSURIZED light is out, close SYST VENT valve on SYSTEM SUPPLY panel.

io. Unlock and open test cell cover.

ip. Pull out circuit breakers on POWER DISTRIBUTION PANEL.

iq. Pull out ELECTRICAL CONTROL panel and remove all patch-cords except resistance patch-cord 3088-8 which is connected between A2-9D and A2-9E.

ir. Using a multimeter, check for continuity of one ohm maximum between the following pins of test cell electrical panel receptacles, jacks of electrical control panel patch-boards, and ground stud E6: (Ground stud E6 is located inside control console adjacent to power distribution panel.)

J25-A and A2-1G	J25-V and A2-8B	J25-j and E6
J25-B and A2-1H	J25-W and A2-8H	J25-k and A2-10I
J25-C and A2-6F	J25-X and E6	J25-m and A2-10J
J25-D and A2-1J	J25-Y and A2-8I	J25-n and E6
J25-E and A2-1I	J25-Z and A2-8J	J25-r and E6
J25-G and A2-2G	J25-a and E6	J25-HH and E6
J25-H and A2-2H	J25-b and A2-9B	J26-A and A1-1I
J25-K and A2-2J	J25-c and A2-9H	J26-B and A1-1H
J25-L and A2-2I	J25-d and E6	J26-C and A1-2I
J25-N and A2-7B	J25-e and A2-9I	J26-D and A1-2J
J25-P and A2-7H	J25-f and A2-9J	J26-E and A1-2H
J25-R and E6	J25-g and E6	J26-F and A1-3I
J25-S and A2-7I	J25-h and A2-10G	J26-G and A1-3J
J25-T and A2-7J	J25-i and A2-10H	J26-H and A1-3H

J26-J and A1-4I
J26-K and A1-4J
J26-L and A1-4H
J26-M and A1-5I
J26-N and A1-5J
J26-P and A1-5H
J26-R and A1-6I
J26-S and A1-6J
J26-T and A1-7I
J26-U and A1-7J
J26-V and A1-8I
J26-W and A1-8J
J26-X and A1-1J
J43 and A2-3J
J44 and A2-3I
J45 and A2-3H
J46 and A2-3G
J47 and A2-3A
J48 and A2-3B
J49 and A2-3C
J50 and A2-3D
J51 and A2-3E
J52 and A2-3F

*is. Check for continuity of one ohm maximum between the following patch-board jacks:

A2-1E and A2-1F
A2-4A and A2-4B
A2-4B and A2-4C
A2-4G and A2-4H
A2-4I and A2-4J

*it. Using multimeter, check for a minimum of one megohm between grounding stud E1 and the following patch-board jacks: (Grounding stud E1 is located inside test cell console adjacent to test cell utility panel.)

A2-1G
A2-1H
A2-1J
A2-6C
A2-6D
A2-6E
A2-7I
A2-7J

*iu. Using multimeter, check for a minimum of one megohm between grounding stud E1 and posts J43 through J52 on test cell electrical panel.

*iv. When LN_2 storage tank has been depleted of all liquid nitrogen (as indicated by melting of frost on the lines), close LN_2 TANK VENT valve and disassemble test setup. Up to 8 hours may be required to boil off a half-full storage tank.

12-45A. LEAK- AND FUNCTION-TESTING (CONSOLES INCORPORATING MD2 CHANGE). Testing the console requires checking all relief valves for proper opening pressures. Two of the relief valves have an opening pressure of 6,400 ±320 psig, which is above the operating pressure of the console. These valves may, at the option of personnel performing the test and with adequate safeguards, be tested while installed in the console. Applying pressures above the operating range of the console is permissible, with adequate safety measures, since the console has been proof-tested to 9,000 psig. A minimum of 6,750 psig of helium pressure must be available to the console to test these valves while installed. If the operator chooses not to test these valves while installed, they must be removed, checked to the requirements of step ff, and reinstalled prior to beginning this test. Procedures include a complete and an abbreviated test. A complete test is accomplished by performing all steps in the procedure. An abbreviated test is accomplished by omitting steps preceded by an asterisk. As an aid in trouble-shooting, see figures 12-8 through 12-18 for schematics and wiring diagrams.

NOTE

All operations are performed on ELECTRICAL CONTROL panel unless noted otherwise.

- The following abbreviations are used in this test:

PUVPC	PU Valve Position Controller Panel
DVM	Digital Voltmeter Panel

a. Prepare console for electrical use (paragraph 12-27). Preparation of individual electrical panels for electrical use is not necessary, since the remaining electrical panels are prepared as required during the test. Provide power to 115 VAC 30 AMP electrical outlets.

b. Depress LAMP TEST switch. SYSTEM PRESSURIZED light and all lights on ELECTRICAL CONTROL panel come on. Release LAMP TEST switch. All lights go off except ON light.

c. Make sure liquid level gage, located at end of hydraulic pump reservoir, indicates a liquid level. If liquid is not observed in sight gage, fill reservoir. Refer to paragraph 12-55 for filling.

d. Open test cell cover by simultaneously depressing then releasing both OPEN TEST CELL buttons on test cell utility panel. Test cell cover opens and automatically stops when fully open. Cover is fully open when a clearance of 0.025 to 0.040 inch is reached at any point between any one test cell cover hinges and stop pads. If doubt exists as to correct adjustment of cover open switch, operator must be prepared to stop cover by depressing and holding one CLOSE TEST CELL button.

e. Check for minimum clearance of 0.025 to 0.040 inch between test cell cover hinge and stop pad at any point. If clearance is not satisfactory, refer to paragraph 12-69 for adjustment.

f. Depress and hold both CLOSE TEST CELL buttons until test cell cover is fully closed. Cover remains fully closed when buttons are released.

g. Warm hydraulic oil by opening and closing test cell cover several times before continuing test.

h. Open test cell cover by simultaneously depressing then releasing both OPEN TEST CELL buttons. Test cell cover must operate smoothly and be fully open within 25-40 seconds. If test cell cover does not operate satisfactorily, refer to paragraph 12-63 for adjustment.

i. Inspect hydraulic system for evidence of fluid leakage. Hydraulic system must be free of leakage, as indicated by a lack of fluid at pressurized connections.

j. Depress left-hand CLOSE TEST CELL button. Test cell cover must not move. Release button.

k. Depress right-hand CLOSE TEST CELL button. Test cell cover must not move. Release button.

l. Depress both CLOSE TEST CELL buttons. Before cover is fully closed release buttons. Test cover must automatically move to fully open position.

m. Depress left-hand OPEN TEST CELL button. Cover must remain closed. Release button.

n. Depress right-hand OPEN TEST CELL button. Cover must remain closed. Release button.

o. Open test cell cover.

p. Depress ON-STANDBY switch-light. ON light goes off and STANDBY light comes on.

*q. Deenergize facility power and disconnect electrical connectors to console receptacles J7 and J8. STANDBY light goes off.

*r. Energize facility power.

*s. Check and record voltage between the following of each of the cables which connect to receptacles J7 and J8. On connector J8, voltage checks must be made from each phase pin. (Use multimeter.) See figure 12-10 for voltage and pin functions.

(1) Phase to neutral.

(2) Phase to ground.

(3) Ground to neutral (not to exceed one volt).

*t. Deenergize facility power.

u. Pull out ELECTRICAL CONTROL panel and remove any patch-cords.

*v. Check for continuity between the following: (Receptacles J25, J26, and J43 through J52 are in test cell. Ground stud E1 is at rear of PUVPC. Ground stud E6 is located inside control console adjacent to power distribution panel.)

J25-A and A2-1G
J25-B and A2-1H
J25-C and A2-6F
J25-D and A2-1J
J25-E and A2-1I
J25-G and A2-2G
J25-H and A2-2H
J25-K and A2-2J
J25-L and A2-2I
J25-N and A2-7B
J25-P and A2-7H
J25-R and E6
J25-S and A2-7I
J25-T and A2-7J
J25-V and A2-8B
J25-W and A2-8H
J25-X and E6
J25-Y and A2-8I
J25-Z and A2-8J

J25-a and E6
J25-b and A2-9B
J25-c and A2-9H
J25-d and E6
J25-e and A2-9I
J25-f and A2-9J
J25-g and E6
J25-h and A2-10G
J25-i and A2-10H
J25-j and E6
J25-k and A2-10I
J25-m and A2-10J
J25-n and E6
J25-r and E6
J25-HH and E6
J26-A and A1-1I
J26-B and A1-1H
J26-C and A1-2I
J26-D and A1-2J

J26-E and A1-2H
J26-F and A1-3I
J26-G and A1-3J
J26-H and A1-3H
J26-J and A1-4I
J26-K and A1-4J
J26-L and A1-4H
J26-M and A1-5I
J26-N and A1-5J
J26-P and A1-5H
J26-R and A1-6I
J26-S and A1-6J
J26-T and A1-7I
J26-U and A1-7J
J26-V and A1-8I
J26-W and A1-8J
J26-X and A1-1J
J43 and A2-3J
J44 and A2-3I

J45 and A2-3H	J51 and A2-3E	A2-4I and A2-4J
J46 and A2-3G	J52 and A2-3F	J7-C and E1
J47 and A2-3A	A2-1E and A2-1F	J8-C and E6
J48 and A2-3B	A2-4A and A2-4B	E1 and E6
J49 and A2-3C	A2-4B and A2-4C	
J50 and A2-3D	A2-4G and A2-4H	

*w. Check for a minimum of one megohm between grounding stud E1 and the following (use multimeter):

A2-1G	A2-7I	J47
A2-1H	A2-7J	J48
A2-1J	J43	J49
A2-6C	J44	J50
A2-6D	J45	J51
A2-6E	J46	J52

*x. Reconnect electrical connectors to console receptacles J7 and J8.

y. Install patch-cords between the following jacks: (Use dual patch-cords K9 when connections are coded with an asterisk. In all others, single patch-cords K2 or dual patch-cords K9 may be used.)

A1-1A to A1-1F	A1-4B to A1-5A	A1-9A to A2-2A
A1-1B to A1-2A*	A1-4C to A1-3D	A1-9F to A1-9G
A1-1C to A1-2D	A1-5B to A1-6A	A1-9J to A1-8G
A1-1D to A2-5F	A1-5C to A2-1E	A1-10A to A2-2E
A1-1G to A2-4I	A1-6B to A1-7A	A1-10C to A2-4C
A1-2A to A2-5D	A1-6C to A1-5D	A1-10F to A1-10G
A1-2B to A1-3A	A1-7B to A1-8A	A1-10J to A1-8F
A1-2C to A2-5J	A1-7C to A1-8D	A2-4F to A2-4H
A1-3B to A1-4A	A1-8B to A1-9C	A2-4J to A2-4E
A1-3C to A1-4D	A1-8C to A1-7D	

z. Install resistance patch-cord 3088-3 across A1-6D and A2-1A. Disregard color-coding on leads.

aa. Make sure patch-cords installed in steps y and z are connected to proper jacks. Close ELECTRICAL CONTROL panel. For an aid to troubleshooting, see figure 12-7A.

*ab. Energize facility power to console. STANDBY light comes on.

ac. Depress ON-STANDBY switch-light. ON light comes on and STANDBY light goes off.

ad. Rotate MONITOR VOLTS RANGE SELECT to D(0-30).

ae. Check indication on MONITOR VOLTS meter. Indication must not exceed 0.5 volt.

af. Rotate VOLTAGE ADJUST to INCREASE until MONITOR VOLTS meter indicates between 26 and 28 volts. Note indication.

ag. Rotate MONITOR VOLTS RANGE SELECT to C(0-75). MONITOR VOLTS meter indicates within one volt of indication obtained in step af.

ah. Rotate VOLTAGE ADJUST to INCREASE until MONITOR VOLTS meter indicates between 32 and 34 volts. Note indication.

ai. Rotate MONITOR VOLTS RANGE SELECT to B(0-150). MONITOR VOLTS meter indicates within 2 volts of indication obtained in step ah.

aj. Move LIGHTS TEST CELL switch on test cell utility panel to ON, then to OFF. Test cell lights come on and go off.

*ak. Measure voltages at each of the following sockets of the 3 receptacles on test cell utility panel: (Voltages obtained in substeps 1 and 2 must be within 2 volts of each other and voltage recorded between J8-B and neutral in step s.)

(1) Phase to neutral.

(2) Phase to ground.

(3) Ground to neutral (not to exceed one volt).

NOTE

Ground is the D-shaped socket. When the receptacle is installed with the ground uppermost, the phase socket is, when facing the receptacle, on the left and the neutral socket is on the right.

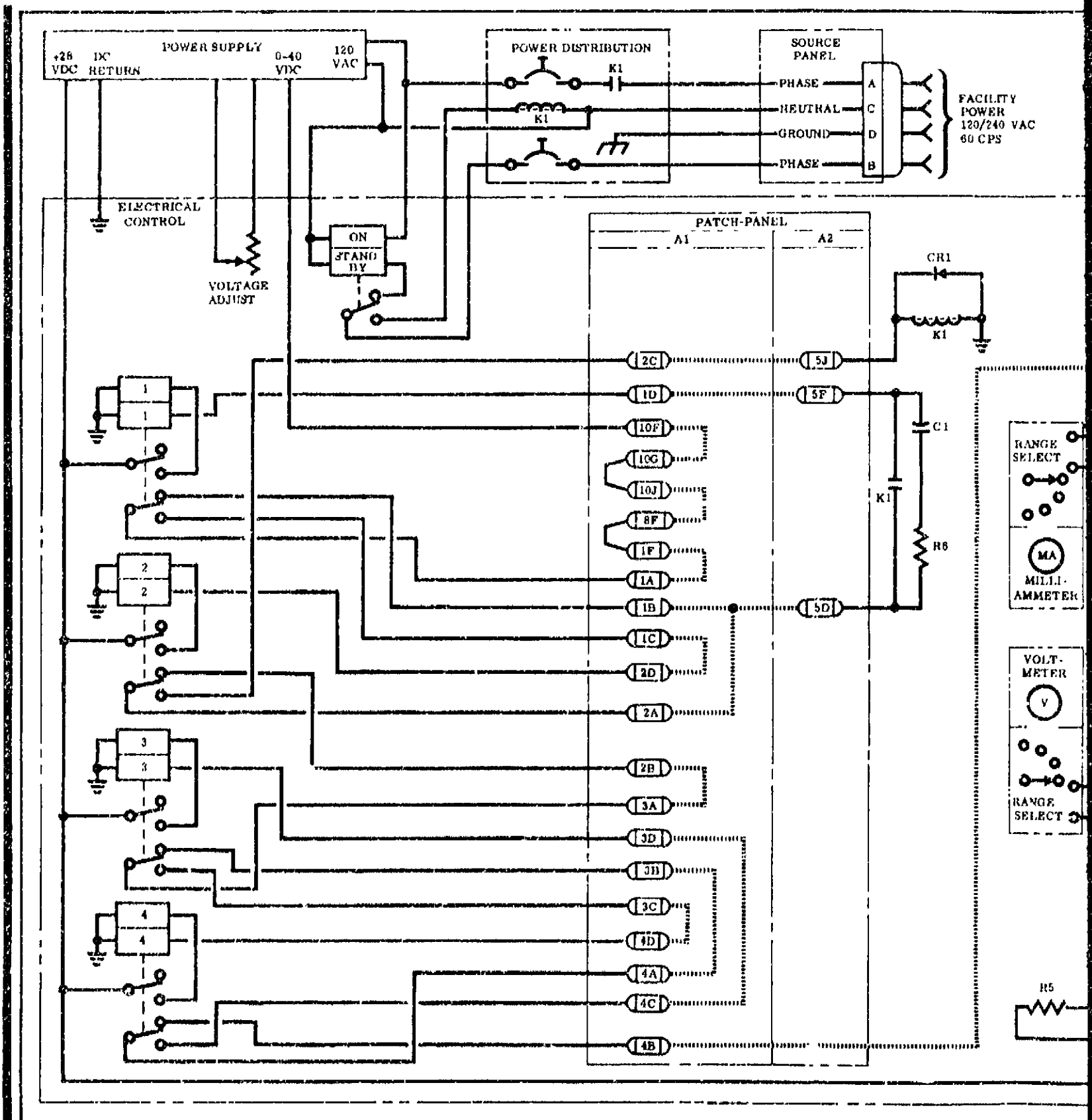
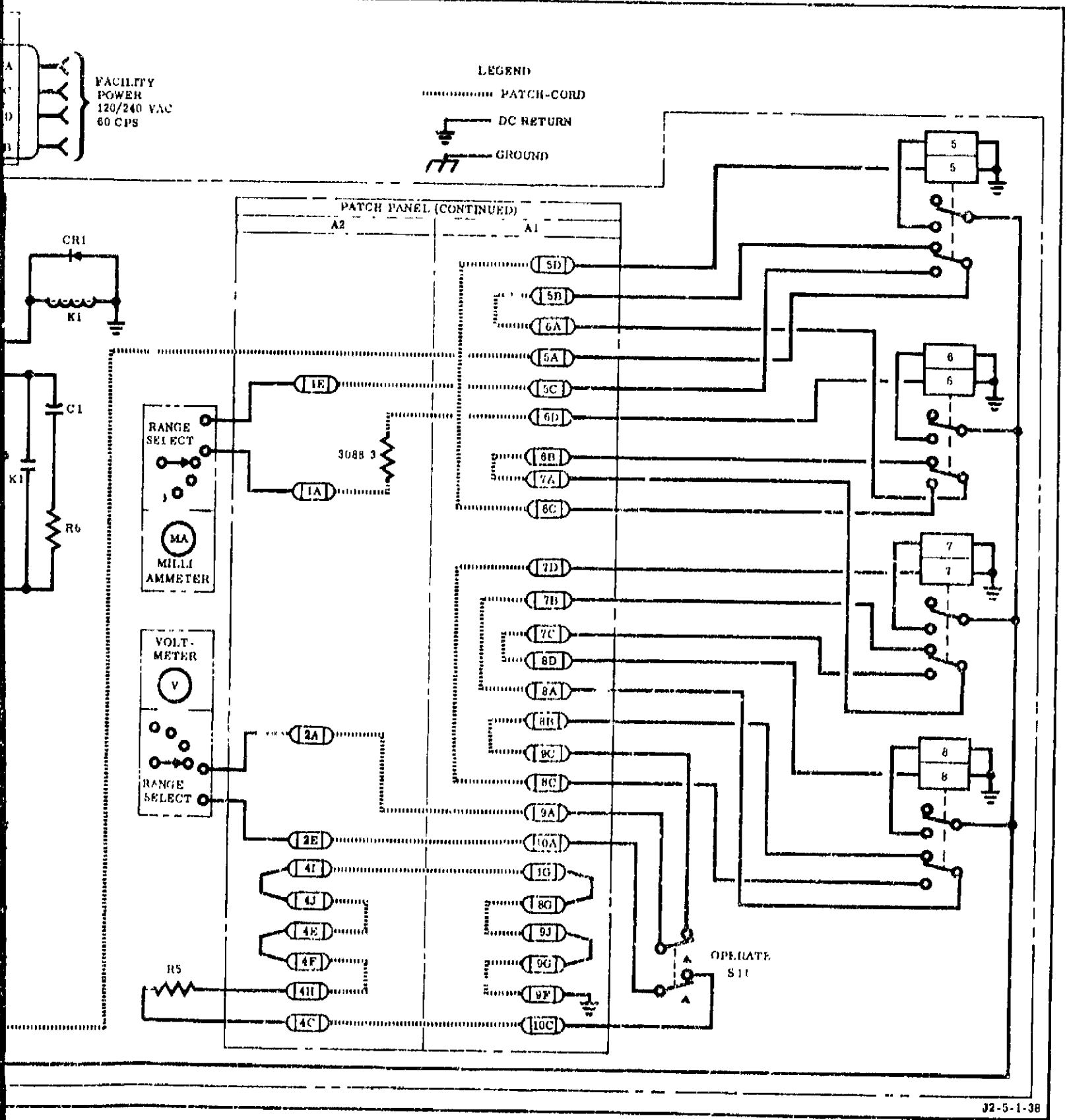


Figure 12-7A. Patch-Panel Functional Arrangement No. 1


FACILITY POWER 120/240 VAC 60 CPS
LEGEND
PATCH-CORD
DC RETURN
GROUND
PATCH PANEL (CONTINUED)
A2
A1
CR1
K1
C1
K1
R6
RANGE SELECT
MA
MILLI AMMETER
3088 3
VOLT-METER
V
RANGE SELECT
R5
1E
1A
2A
2E
4F
4J
4E
4F
4H
4C
5D
5B
6A
5A
5C
6D
6B
7A
8C
7D
7B
7C
8D
8A
8B
9C
8C
9A
10A
1G
8G
9J
9G
9F
10C
OPERATE
S11
5
5
6
6
7
7
8
8

J2-5-1-38

*al. Measure voltages at outlets 602A, 602B, 603A, 603B, 604A, 604B, 605A, and 605B. (Remove electrical connectors as necessary to check voltages, replacing them as the checks are completed.) Voltages obtained in substeps 1 and 2 must be within 2 volts of each other and the voltage recorded between J8-B and neutral in step s.

(1) Phase to neutral.

(2) Phase to ground.

(3) Ground to neutral (not to exceed one volt).

am. Deenergize CIRCUIT BREAKER on test cell utility panel.

an. Rotate VOLTAGE ADJUST to full DECREASE. MONITOR VOLTS meter indicates 0.5 volt maximum.

ao. Depress switch-lights 1 through 8. Upper lights 1 through 8 come on as respective switch-light is depressed.

ap. Depress switch-lights 1 through 8. Upper lights 1 through 8 go off as respective switch-light is depressed.

aq. Rotate MONITOR VOLTS RANGE SELECT to D(0-30).

ar. Rotate VOLTAGE ADJUST to INCREASE until MONITOR VOLTS meter indicates between 26 and 28 volts.

as. Rotate MONITOR MILLIAMPERES RANGE SELECT to B(0-500). MONITOR MILLIAMPERES meter indicates 0.5 division maximum.

at. Depress twice, each of the switch-lights listed in column A. Lights listed in column B come on when associated switch-light is depressed the first time and go off when switch-light is depressed the second time. MONITOR VOLTS meter indicates 26-28 volts while lights are off and 0.5 volt maximum while lights are on. MILLIAMPERES indication does not change. Switch-lights may be depressed in any order; however, each switch-light must be depressed twice before proceeding to the next one.

A	B
1	1 upper and 2 lower
2	2 upper and 1 lower
3	3 upper and 4 lower
4	4 upper and 3 lower
6	6 upper and 5 lower
7	7 upper and 8 lower
8	8 upper and 7 lower

au. Depress switch-light 5. Upper light 5 and lower light 6 come on. MONITOR MILLIAMPERES meter indicates 50-90 milliamperes, and MONITOR VOLTS meter indication decreases to 0.5 volt maximum.

av. Rotate VOLTAGE ADJUST to full DECREASE. MONITOR MILLIAMPERES meter indication decreases to a maximum indication of 0.5 division. Light 6 loses brilliance and goes out.

aw. Rotate MONITOR MILLIAMPERES RANGE SELECT to D(0-50).

ax. Rotate VOLTAGE ADJUST to INCREASE until MONITOR MILLIAMPERES meter indicates 45-50 milliamperes. Note indication. Lower light 6 may come on. If light does come on, brilliancy is low.

ay. Rotate MONITOR MILLIAMPERES RANGE SELECT through C(0-250), B(0-500), A(0-500) X2, and OFF. Indication remains within 10 milliamperes of indication noted in step ax. If on, an increase in brilliancy of lower light 6 may be noted; if not on, light may come on at a low brilliancy as switch is moved through higher ranges. Light indication, if any, goes off and milliampere meter indicates a maximum of 0.5 division when switch is positioned to OFF.

az. Rotate MONITOR VOLTS RANGE SELECT to OFF.

azA. Depress switch-light 5. Upper light 5 goes off.

ba. Depress ON-STANDBY switch-light. ON light goes off and STANDBY light comes on.

bb. Pull out ELECTRICAL CONTROL panel and remove all patch-cords.

bc. Install patch-cords between the following jacks: (Use dual patch-cords K9 when connections are coded with an asterisk. In all others, single patch-cords K2 or dual patch-cords K9 may be used.)

A1-1A to A1-10D*	A1-4C to A2-1B
A1-1A to A1-2A*	A1-5A to A1-5D
A1-1C to A2-2B	A1-5C to A2-1C
A1-2A to A1-3A*	A1-6A to A1-6D
A1-2C to A2-2C	A1-6C to A2-1D
A1-3C to A2-2D	A1-9D to A2-2F

bd. Install resistance patch-cord 3088-3 across A1-3A and A2-1E. Disregard color-coding on leads.

be. Connect resistance patch-cord 3088-6 to the following jacks: (Connect yellow lead to jack noted. Disregard color-coding on remaining 2 leads.)

A1-4A
A1-6F (Yellow)
A1-9E

bf. Make sure patch-cords installed in steps be through be are connected to proper jacks. Close ELECTRICAL CONTROL panel. For an aid to trouble-shooting, see figure 12-7B.

bg. Depress ON-STANDBY switch-light. STANDBY light goes off and ON light comes on.

bh. Depress switch-light 1. Upper light 1 comes on and MONITOR VOLTS meter indicates a value.

bi. Rotate VOLTAGE ADJUST to INCREASE until MONITOR VOLTS meter indicates between 28 and 30 volts on 0-30 volt scale.

bj. Depress switch-light 1. Upper light 1 goes off and MONITOR VOLTS meter indicates 0.5 volt maximum on 0-30 volt scale.

bk. Depress switch-light 2. Upper light 2 comes on and MONITOR VOLTS meter indicates between 27 and 31 volts on 0-75 volt scale.

bl. Depress switch-light 2. Upper light 2 goes off and MONITOR VOLTS meter indicates 0.5 volt maximum on 0-30 volt scale.

bm. Depress switch-light 3. Upper light 3 comes on and MONITOR VOLTS meter indicates between 26 and 32 volts on 0-150 volt scale.

bn. Depress switch-light 3. Upper light 3 goes off and MONITOR VOLTS meter indicates 0.5 volt maximum on 0-30 volt scale.

bo. Depress switch-light 4. Upper light 4 goes on and MONITOR MILLIAMPERES meter indicates between 12 and 17 milliamperes on 0-50 milliampere scale.

bp. Depress switch-light 4. Upper light 4 goes off and MONITOR MILLIAMPERE meter indicates maximum of 0.5 division.

bq. Depress switch-light 5. Upper and lower lights 5 come on and MONITOR MILLIAMPERES meter indicates between 50 and 90 milliamperes on 0-250 milliampere scale.

br. Depress switch-light 5. Upper and lower lights 5 go off and MONITOR MILLIAMPERES meter indicates a maximum of 0.5 division.

bs. Depress switch-light 6. Upper and lower lights 6 come on and MONITOR MILLIAMPERES meter indicates between 50 and 90 milliamperes on 500 milliampere scale.

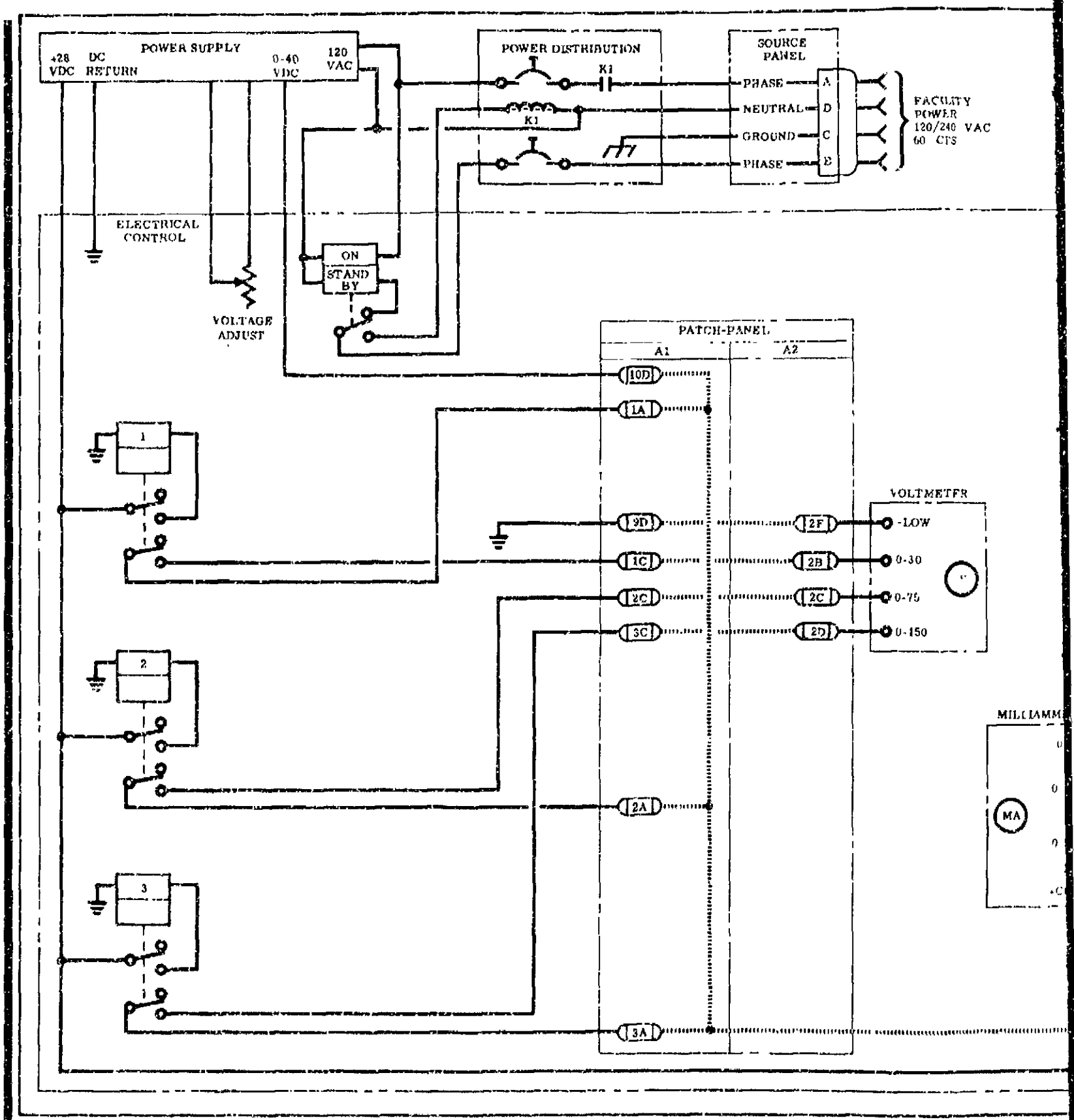
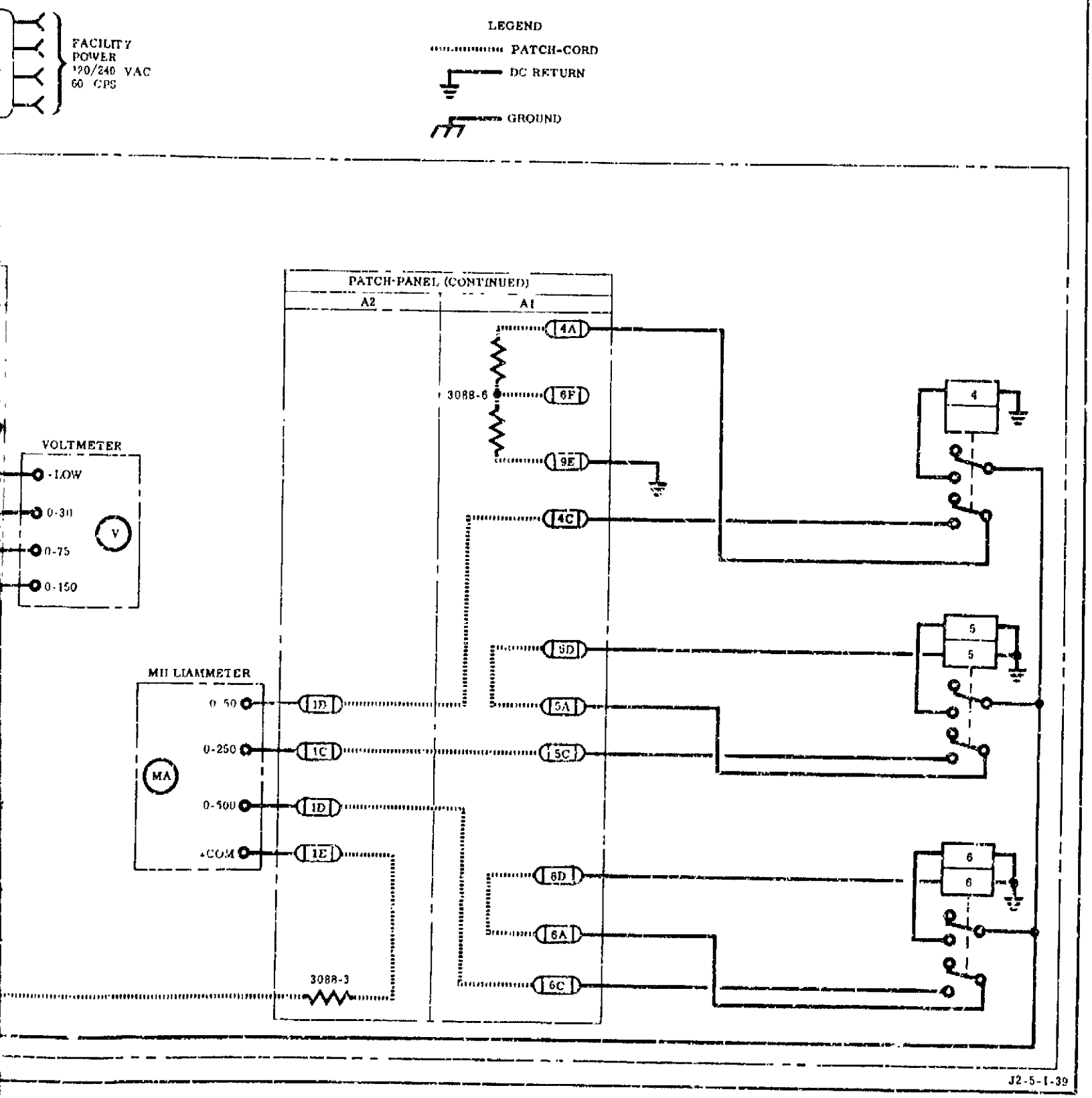


Figure 12-7B. Patch-Panel Functional Arrangement No. 2


FACILITY POWER 120/240 VAC 60 CPS
LEGEND
PATCH-CORD
DC RETURN
GROUND
PATCH-PANEL (CONTINUED)
A2
A1
4A
3088-6
6F
9E
4C
4
VOLTMETER
-LOW
0-30
0-75
0-150
V
5D
5A
5C
5
5
MILLIAMMETER
0-50
0-250
0-500
-COM
MA
1B
1C
1D
1E
6D
6A
6C
6
6
3088-3

bt. Depress switch-light 6. Upper and lower lights 6 go off and MONITOR MILLIAMPERES meter indicates maximum of 0.5 division.

bu. Depress ON-STANDBY switch-light. ON light goes off and STANDBY light comes on.

buA. Remove cover from amplifier Z1 located in PUVPC panel and turn amplifier gain control fully clockwise, then 1/8 to 1/4 turn counterclockwise. Replace cover.

bv. Pull out ELECTRICAL CONTROL panel and remove all patch-cords. Pull out panel sufficiently to lock in open position.

bw. Install patch-cords between the following jacks: (Use dual patch-cords K9 when connections are coded with an asterisk. In all others, single patch-cords K2 or dual patch-cords K9 may be used.)

A1-1A to A2-6A*
A1-1A to A2-8C
A1-1C to A2-2A
A1-2A to A2-6B*
A1-2C to A2-2E
A1-5F to A2-8F
A1-7A to A2-7A
A1-7C to A2-6I*
A1-8A to A2-6G*
A1-8C to A2-7D
A1-8G to A2-8E*
A1-9D to A2-2F*
A1-10D to A2-2B*
A2-1G to A2-3C*
A2-1G to A2-6C*
A2-1H to A2-6D
A2-1H to A2-3B*
A2-1J to A2-3A*
A2-1J to A2-6E
A2-6A to A2-7J
A2-6B to A2-7I*
A2-7D to A2-7F
A2-7I to A2-8D

bx. Adjust resistance patch-cord 3088-4 to 95-105K ohms. (Use multimeter.)

by. Connect resistance patch-cords as follows (unless color coding of leads is noted, coding may be disregarded):

(1) 3088-1 to

A2-6G (Red)
A2-6H (Yellow)
A2-6I (Black)
A2-6J (Blue)

(2) 3088-4 (pre-set to 95-105K) to:

A1-8F
A2-6C

(3) 3088-5 to:

A2-3A
A2-8E

(4) 3088-6 to:

A1-6F
A1-7F
A1-7G (Yellow)

bz. On PUVPC, connect METER CALIBRATE red jack to A1-10D and METER CALIBRATE black jack to A1-9D. Use test lead kit 699.

ca. Connect A1-7B to terminal 3 of potentiometer R1 (COARSE ADJT.) on rear of PUVPC. Multimeter lead may be used for this task. Route lead from patchboard to rear of panel through opening created by open ELECTRICAL CONTROL panel. Leave ELECTRICAL CONTROL panel locked open during this phase of test, to prevent damage to electrical lead.

cb. Make sure patch-cords and electrical leads installed in steps bw and by through ca are connected to proper jacks. For an aid to troubleshooting, see figure 12-7C.

cc. Rotate VOLTAGE ADJUST to full DECREASE.

cd. Depress ON-STANDBY switch-light. STANDBY light goes off and ON light comes on.

ce. Prepare DIGITAL VOLTMETER for use by performing pre-use adjustment of digital voltmeter (paragraph 12-29). While DIGITAL VOLTMETER is warming up, steps cf through ck may be performed.

cf. Connect HORIZONTAL and VERTICAL ground straps and position OSCILLOSCOPE controls as follows:

(1) FOCUS to 12 o' clock.

(2) HORIZONTAL DISPLAY to 10 volts/CM.

(3) HORIZONTAL VERNIER to CAL.

(4) HORIZONTAL POSITION to 12 o'clock.

(5) HORIZONTAL AC-DC to AC.

(6) TRIGGER SOURCE to INT. +.

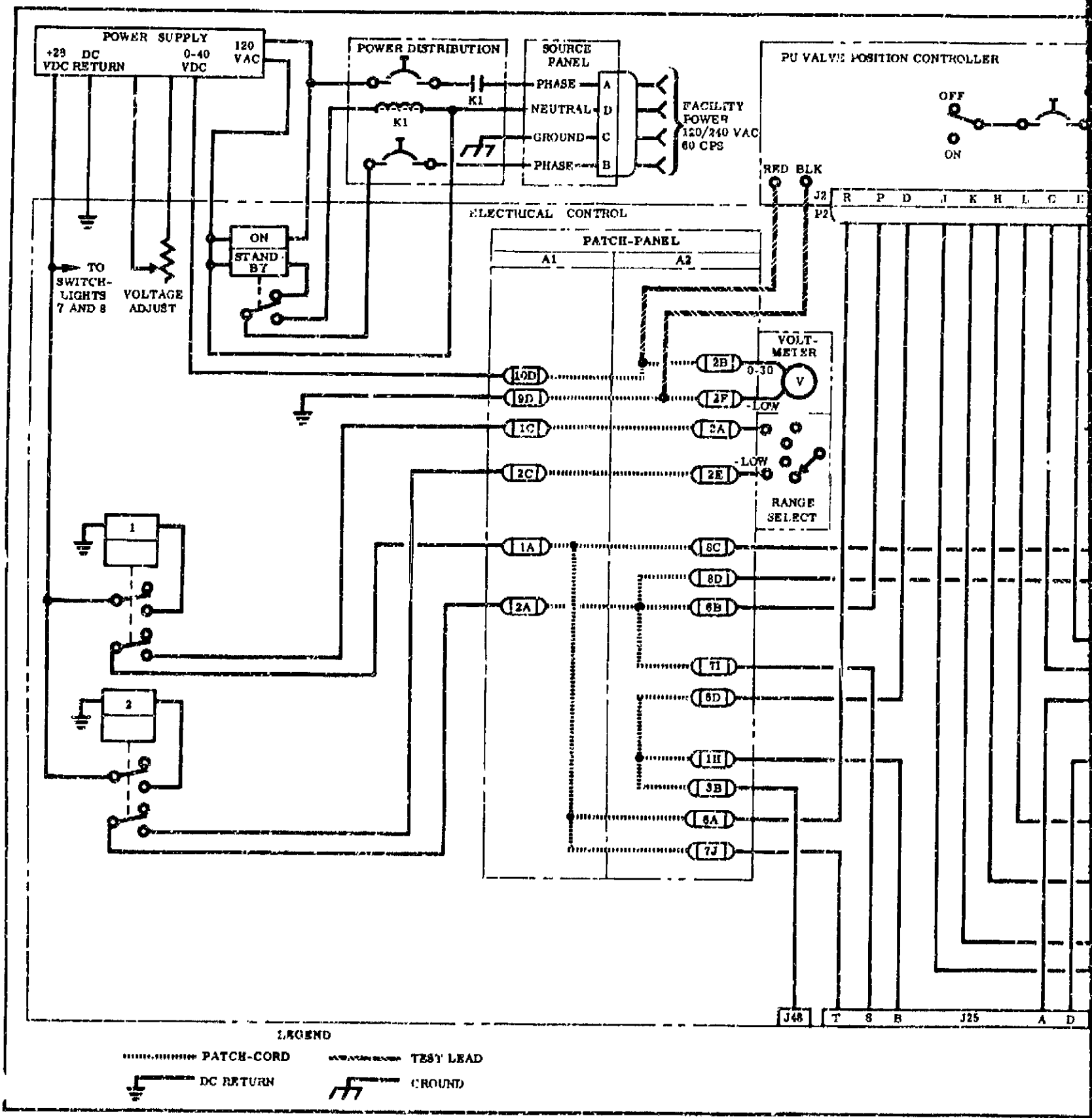
(7) TRIGGER LEVEL to AUTO.

(8) SWEEP MAGNIFIER to X1.

(9) VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

(10) VERTICAL VERNIER to CAL.

(11) VERTICAL POSITION to 12 o'clock.


POWER SUPPLY
+28 VDC RETURN
DC
0-40 VDC
120 VAC
POWER DISTRIBUTION
K1
K1
SOURCE PANEL
PHASE
NEUTRAL
GROUND
PHASE
A
D
C
B
FACILITY POWER 120/240 VAC 60 CPS
PU VALVE POSITION CONTROLLER
OFF
ON
RED BLK
J2
P2
R P D J K H L C
ELECTRICAL CONTROL
ON
STAND BY
TO SWITCH-LIGHTS 7 AND 8
VOLTAGE ADJUST
PATCH-PANEL
A1
A2
VOLT-METER
0-30
V
-LOW
-LOW
RANGE SELECT
10D
9D
1C
2C
1A
2A
2B
2F
2A
2E
8C
8D
6B
7I
6D
1H
3B
6A
7J
1
2
J48
T S B
J25
A D
LEGEND
PATCH-CORD
TEST LEAD
DC RETURN
GROUND

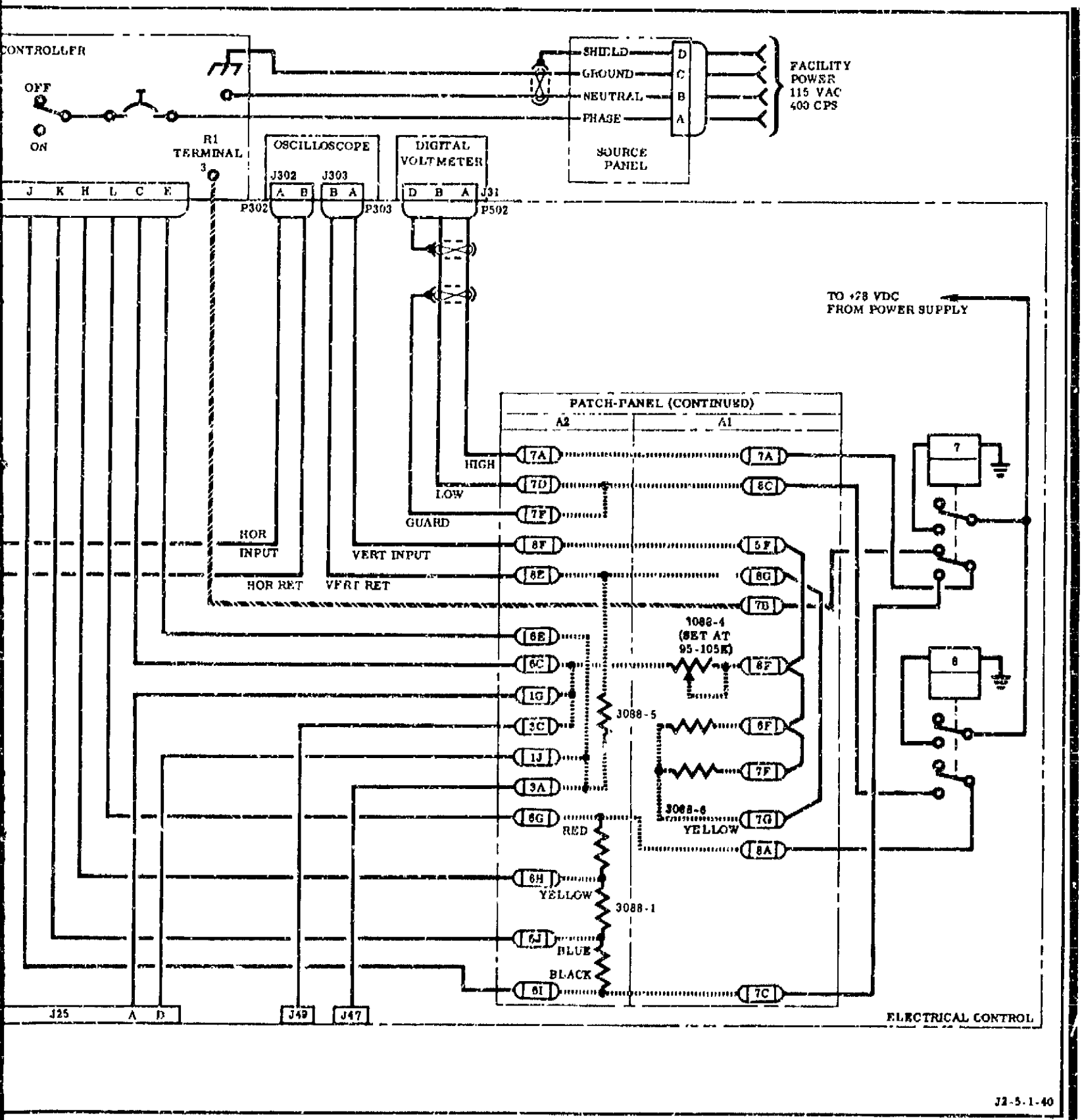


Figure 12-7C. Patch-Panel Functional Arrangement No. 3

(12) VERTICAL AC-DC to DC.

(13) Rotate INTENSITY & POWER just enough to turn on power, maintaining minimum intensity.

cg. Turn CHANNEL SELECT switch on PRESSURE/TEMPERATURE MONITOR panel to 2.

ch. Observe temperature indicator and apply a source of heat or cold to low-flow temperature transducer. Low-flow transducer can be identified by connector P15 connected to it. Temperature meter must indicate an increase or decrease in indicated temperature. An acceptable method of applying heat is to enfold with both hands the housing in which transducer is installed. A temperature increase of 5° or more can thus be obtained.

ci. Turn CHANNEL SELECT switch on PRESSURE/TEMPERATURE MONITOR panel to 3.

cj. Repeat step ch on high-flow temperature transducer (High-flow transducer can be identified by connector P18 connected to it.)

ck. Turn CHANNEL SELECT switch on PRESSURE/TEMPERATURE MONITOR panel to OFF.

cl. If pre-use adjustment of DIGITAL VOLTMETER (paragraph 12-29) has not been completed, complete it before continuing test.

cm. Position DIGITAL VOLTMETER controls as follows:

(1) RANGE to 100V.

(2) ATTEN to 12 o'clock.

(3) SAMPLING RATE to STOP.

cn. Position PUVPC controls as follows:

(1) METER CALIBRATE toggle down.

(2) Meter select to NOMINAL VALVE OPENING.

(3) VALVE POSITION INPUT REFERENCE - COARSE ADJT and FINE ADJT to 00.

(4) Circuit breaker energized.

co. On PUVPC, move toggle switch below AC POWER ON light to upper position. AC POWER ON light comes on and VALVE OPENING meter indicates between 60 and 74 percent.

cp. Momentarily deenergize circuit breaker on PUVPC. AC POWER ON goes off and VALVE OPENING meter indicates one division maximum while circuit breaker is deenergized.

cq. Rotate VOLTAGE ADJUST to INCREASE until MONITOR VOLTS meter indicates between 24 and 25 volts.

cr. Momentarily actuate METER CALIBRATE switch on PUVPC. VALVE OPENING meter indicates between 90 and 100 percent while switch is actuated.

cs. Momentarily depress meter position switch to PUVPC to VALVE OPENING. VALVE OPENING meter indicates between 30 and 37 percent while switch is in VALVE OPENING position.

ct. Rotate VOLTAGE ADJUST to full DECREASE. MONITOR VOLTS meter indicates 0.5 volt maximum on 0-30 volt scale.

cu. Depress ON-STANDBY switch-light. ON light goes off and STANDBY light comes on.

cv. Remove patch-cords and test leads connecting the following:

(1) A1-10D to A2-2B and METER CALIBRATE red jack.

(2) A1-9D to A2-2F and METER CALIBRATE black jack.

cw. Depress ON-STANDBY switch-light. STANDBY light goes OFF and ON light comes on.

cx. On DVM, rotate SAMPLING RATE to 12 o'clock.

cy. Depress switch-lights 7 and 8. Upper lights 7 and 8 come on and digital voltmeter indicates between volt -025.050 and volt -024.950. If voltage is obtained, proceed to step da. If voltage is not obtained, perform step cz.

cz. Adjust PUVPC A2 power supply to obtain voltage requirements of step cy. Voltage adjustment is located on top of power supply and is accessible through cover.

da. Depress switch-light 7. Upper light 7 goes out and digital voltmeter indicates between volt +025.050 and volt +024.950. If voltage is obtained, proceed to step dc. If voltage is not obtained, perform step db.

db. Adjust PUVPC A1 power supply to obtain voltage requirements of step da. Voltage adjustment is located on top of power supply and is accessible through cover.

dc. On DVM, rotate SAMPLING RATE to STOP.

dd. Depress switch-light 8. Upper light 8 goes out.

de. Rotate MONITOR VOLTS RANGE SELECT to A(0-150 AC).

df. Depress switch-lights 1 and 2. Upper lights 1 and 2 come on and MONITOR VOLTS meter indicates 70-90 volts.

dg. Depress switch-lights 1 and 2. Upper lights 1 and 2 go off and MONITOR VOLTS meter indicates 0.5 volt maximum.

dh. On oscilloscope, rotate INTENSITY & POWER control clockwise and adjust FOCUS to obtain a sharp, clear pattern.

di. On oscilloscope, adjust HORIZONTAL and VERTICAL VERNIERS as required to obtain a pattern approximating the pattern shown in figure 12-7D, view A. Vary resistance patch-cord 3088-4 to minimize crossovers at extreme ends of pattern.

dj. On PUVPC, rotate COARSE ADJT clockwise to 100. Oscilloscope pattern shifts and approximates pattern shown in figure 12-7D, view B.

dk. On oscilloscope, rotate INTENSITY & POWER control counterclockwise until pattern is no longer visible on scope.

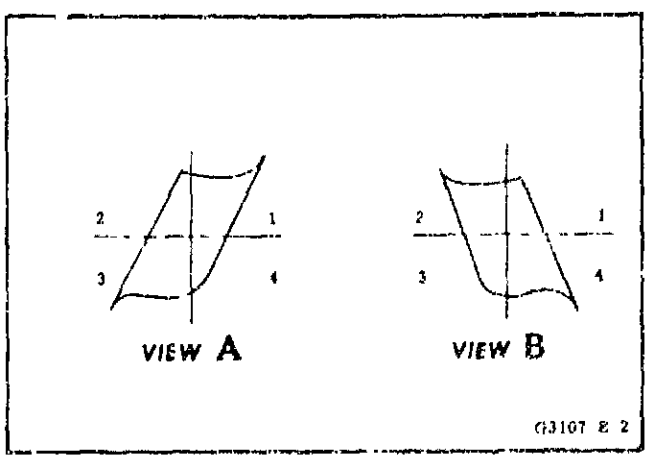


Figure 12-7D. Oscilloscope Pattern No. 1

dl. Verify that voltages between the following connections are within the value noted: (These voltages are at a frequency of 400 cps. Use multimeter.)

(1) J47 and J48: 20-35 volts.

(2) J47 and J49: 40-70 volts.

(3) J48 and J49: 20-35 volts.

dm. Depress ON-STANDBY switch-light. ON light goes off and STANDBY light comes on. Power to oscilloscope and digital voltmeter go off.

dn. On PUVPC, move switch below AC POWER ON light to OFF. AC POWER ON light goes off and VALVE OPENING meter indicates ± one percent maximum.

do. Remove resistance patch-cords 3088-1 and 3088-4 and patch-cord connecting A1-7C to A2-6I. Disconnect test lead from A1-7B only. Leave other end connected to terminal 3 of potentiometer R1 (COARSE ADJT).

dp. Adjust resistance patch-cord 3088-4 to 95-105K ohms. Use multimeter.

dq. Connect resistance patch-cord 3088-4 to A1-8F and A2-6C. Disregard color-coding of leads.

dr. Connect loose end of lead connected to terminal 3 of potentiometer R1 (COARSE ADJT.) to A1-7C.

ds. Install patch-cords between the following jacks:

A1-4A to A2-6J	A1-6B to A2-10D
A1-4C to A2-2J	A1-6C to A2-10F
A1-5A to A2-10A	A2-2G to A2-6H
A1-5B to A2-10C	A2-2H to A2-6J
A1-5C to A2-10E	A2-2I to A2-6G
A1-6A to A2-10B	

dt. Make sure patch-cords installed in steps dq through ds are connected to proper jacks. To prevent damaging electrical lead to rear of PUVPC, leave ELECTRICAL CONTROL panel locked open. For an aid to troubleshooting, see figure 12-7E.

du. On PUVPC, rotate COARSE ADJT. to 00.

dv. Connect actuator assembly or propellant utilization valve to connector J25 in test cell with cable assembly 103198 or 9026548.

dvA. Connect a jumper wire equipped with alligator clips between flange of propellant utilization valve actuator housing and shielding tab on clamping nut of connector P25.

dvB. Using multimeter, check that resistance between propellant utilization valve actuator housing flange and either black terminal post on front of oscilloscope panel is less than one ohm.

dw. Depress ON-STANDBY switch-light. STANDBY light goes off and ON light comes on. Power to oscilloscope and digital voltmeter is re-established. Wait 2 minutes and depress RESET switch on digital voltmeter panel.

dx. Depress switch-light 4. Upper light 4 comes on.

dy. On PUVPC, move switch below AC POWER ON light up. AC POWER ON light goes on and VALVE OPENING meter indicates between 40 and 60 percent.

dz. On oscilloscope, rotate INTENSITY & POWER control clockwise and adjust FOCUS to obtain a clear, sharp trace.

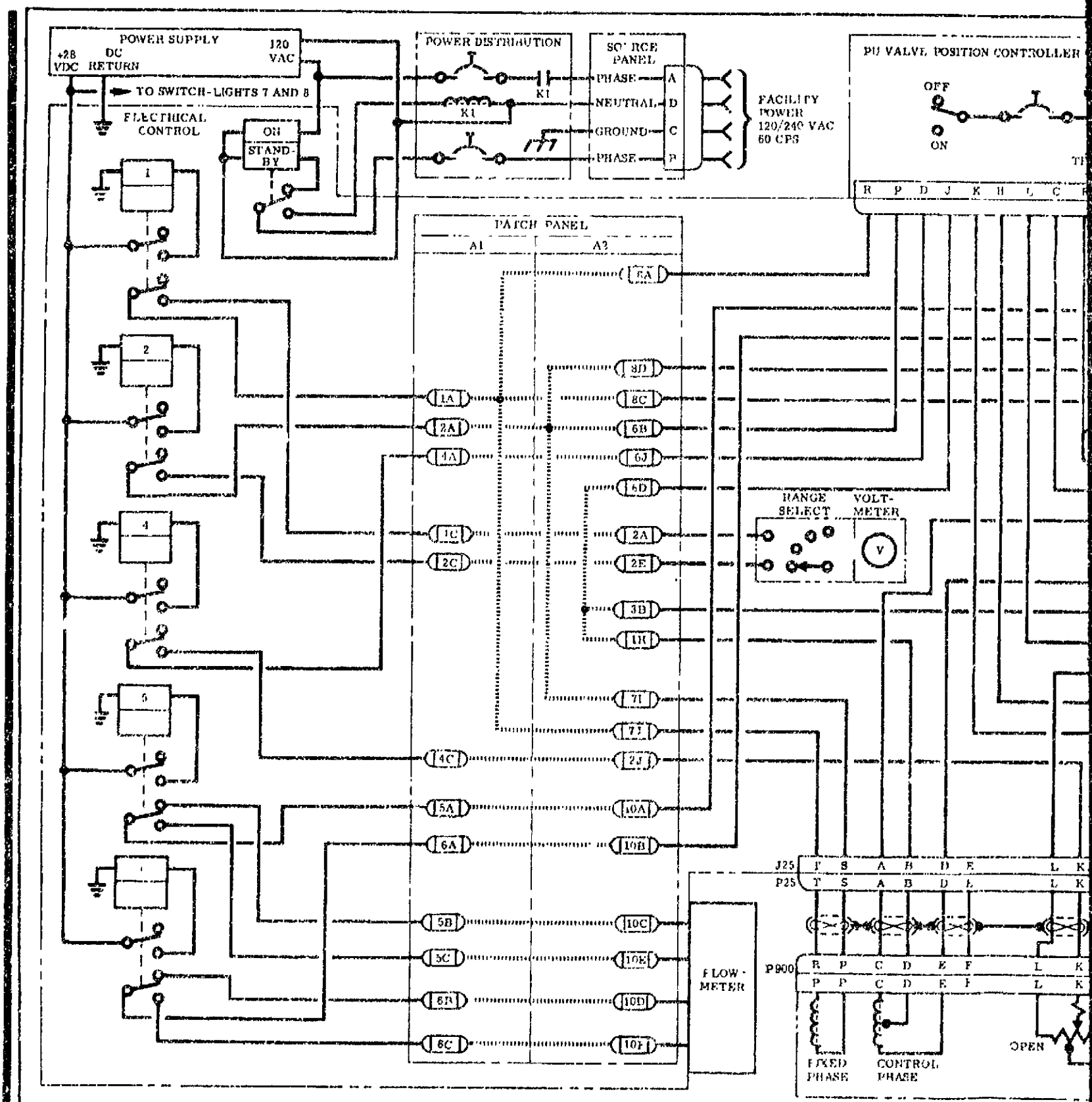
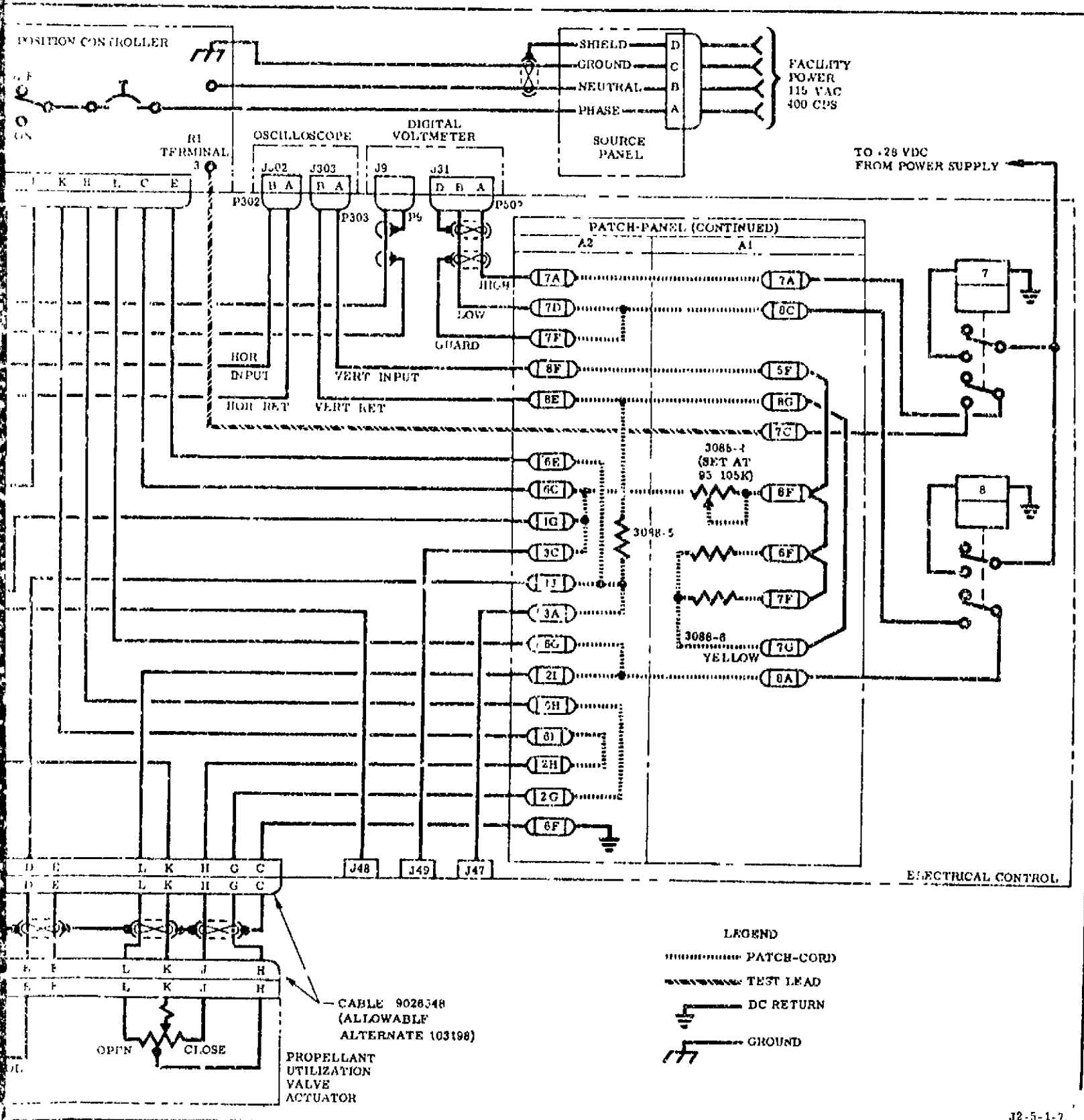


Figure 12-7E. Patch-Panel Functional Arrangement No. 4


POSITION CONTROLLER
SHIELD
GROUND
NEUTRAL
PHASE
D
C
B
A
FACILITY POWER 115 VAC 400 CPS
SOURCE PANEL
R1 TERMINAL 3
OSCILLOSCOPE
DIGITAL VOLTMETER
J302
J303
J9
J31
P302
P303
P9
P503
TO +28 VDC FROM POWER SUPPLY
PATCH-PANEL (CONTINUED)
A2
A1
HIGH
LOW
GUARD
HOR INPUT
VERT INPUT
HOR RET
VERT RET
3086-4 (SET AT 95 105K)
3086-5
3086-6 YELLOW
7
8
J48
J49
J47
ELECTRICAL CONTROL
OPEN
CLOSE
CABLE 9026348 (ALLOWABLE ALTERNATE 103198)
PROPELLANT UTILIZATION VALVE ACTUATOR
LEGEND
PATCH-CORD
TEST LEAD
DC RETURN
GROUND

dzA. Wait 20-21 minutes to permit adequate warm-up for stabilization of valve temperature.

ea. Adjust HORIZONTAL and VERTICAL, POSITION, and VERNIER controls to center and place extremes of pattern on 5 cm lines. (See figure 12-7F.)

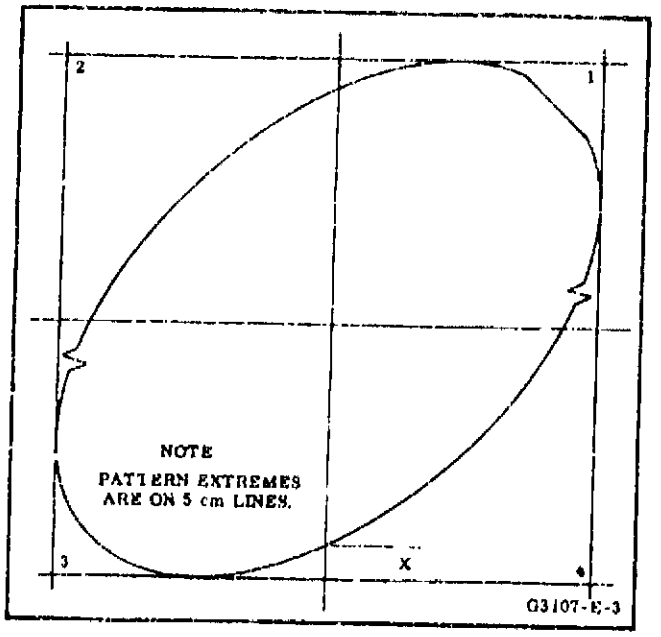


Figure 12-7F. Oscilloscope Pattern No. 2

eb. Verify that dimension X does not exceed 0.2 cm. (See figure 12-7F.)

ec. On PUVPC, rotate COARSE ADJT. to 100. Major areas of pattern shift from quadrants 1 and 3 to 2 and 4. See figure 12-7F for quadrant identification.

ed. On oscilloscope, rotate INTENSITY & POWER control to OFF. Pattern disappears.

ee. On PUVPC, rotate COARSE ADJT. to 00.

ef. Depress switch-lights 1 and 2. Upper lights 1 and 2 come on and MONITOR VOLTS meter indicates between 102 and 127 volts.

eg. Depress switch-lights 1 and 2. Upper lights 1 and 2 go off and MONITOR VOLTS meter indicates 2 volts maximum.

eh. Depress switch-lights 7 and 8. Upper lights 7 and 8 come on.

ei. On DVM, momentarily depress RESET switch. Digital voltmeter indicates between volts +025.050 and volts +024.950.

ej. On DVM, rotate SAMPLING RATE to 12 o'clock.

ek. On PUVPC, rotate COARSE ADJUST clockwise until digital voltmeter indicates between volts +000.310 and volts +000.290.

el. Measure voltage across J47 and J49. Use multimeter set at 60 AC V. Voltage must be between 80 and 90 times indication on digital voltmeter. If proper gain is not obtained, remove amplifier Z1 cover for access to gain adjustment screw, adjust PUVPC amplifier Z1, and reinstall cover when gain has been set.

em. Depress switch-lights 7 and 8. Upper lights 7 and 8 go off and digital voltmeter indicates volts -000.001 to volts +000.001.

en. On DVM, rotate SAMPLING RATE to STOP and depress RESET switch.

eo. On PUVPC, rotate COARSE ADJT. to 00.

ep. (Deleted)

eq. On PUVPC, move meter position switch to VALVE OPENING. VALVE OPENING meter indicates a maximum of 15 percent.

er. On PUVPC, slowly rotate FINE ADJT., then COARSE ADJT. clockwise until VALVE OPENING meter indicates a minimum of 90 percent. After meter indication starts to increase, movement will be steady, related to rate of adjustment.

es. On PUVPC, move switch below AC POWER ON light to OFF. AC POWER ON light goes to off and VALVE OPENING meter indicates 0 ±1 percent.

et. On PUVPC, deenergize circuit breaker.

etA. Depress switch-light 4. Upper light 4 goes out.

eu. Depress ON-STANDBY switch-light. On light goes off and STANDBY light comes on. Electrical power to DVM goes off.

ev. Disconnect and remove propellant utilization valve and cable from test cell.

ew. Remove test lead and all patch-cords except the following from ELECTRICAL CONTROL panel:

A1-5A to A2-10A	A1-6A to A2-10B
A1-5B to A2-10C	A1-6B to A2-10D
A1-5C to A2-10E	A1-6C to A2-10F

ex. Prepare console for pneumatic use (paragraph 12-34), but do not supply facility gaseous nitrogen to console. A minimum of 6,750 psig of helium pressure is required for this test, unless the 6,400-psig relief valves have been previously tested, in which case the minimum required pressure is 5,000 psig.

ey. Vent trapped pressure in console by opening SYST VENT valve on SYSTEM SUPPLY panel. Close SYST VENT valve.

ez. Obtain necessary fittings, packings, and hoses from components adapter set 9016796 and interconnect pneumatic outlets in test cell as follows:

NOTE

Adapters installed in pneumatic outlets must be replaced with appropriate AN-type fittings to permit connection of hoses. Unless specified, sizes of hoses are optional.

(1) PNEU OUTLET MED PRESS to 0-2000 PSIG MON INLET and to 0-1000 PSIG MON INLET.

(2) PNEU OUTLET HIGH PRESS to 0-6000 PSIG MON INLET and to each of the 0-6000 PSIG UTILITY INLETS, with hoses R24525-4-0480.

(3) Install cryogenic hand valves 19-9021936 on tee on liquid nitrogen standpipe and on LN_2 RETURN port. If a 3/4-inch hose is installed between these ports, remove and cap it. Do not remove 1/4-inch hose. Leave 3/4-inch hose in test cell, since it is used later in test. Position valves so that they do not interfere with test cell cover when cover is closed.

(4) Make sure cryogenic hand valves are closed.

ezA. Depress ON-STANDBY switch. STANDBY light goes off, and ON light comes on.

fa. Close and lock test cell cover.

fb. Check for zero leakage past HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel by observing gage on SYSTEM SUPPLY panel for pressure increase.

NOTE

Steps fc through fj check the opening pressures of the 6,400-psig relief valves. If these valves were tested prior to beginning this test, proceed to step fk.

fc. Make sure facility helium supply to console is less than 6,000 psig.

fd. Open HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Facility pressure is indicated on gage on SYSTEM SUPPLY panel.

fe. Caution personnel in immediate vicinity of console of impending venting of high-pressure gases.

WARNING

Venting of high-pressure gases can startle personnel, resulting in injury to personnel and damage to equipment.

ff. Slowly increase helium pressure to console until 6,400-psig relief valve in pneumatic source system opens. Reduce pressure. Valve opens between 6,080 and 6,720 psig. Monitor opening pressure on facility gage having a minimum accuracy of one percent. If valve does not open within tolerance, refer to paragraph 12-65 for adjustment.

fg. Close HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

fh. Make sure facility helium supply to console is less than 6,000 psig. Open SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

fi. Repeat steps fe and ff for 6,400-psig relief valve in LN_2 tank pressure system.

fj. Close SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

fk. Open HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Helium pressure is indicated on SYSTEM SUPPLY panel.

fl. Open NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

fm. Check for zero reverse leakage of check valve which isolates helium source pressure from nitrogen source supply by observing nitrogen SOURCE PRESSURE gage for pressure increase.

fn. Check for zero leakage past SOURCE SHUTOFF VALVE on LN_2 TANK PRESSURE panel by turning and holding PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE, while observing gage on LN_2 TANK PRESSURE panel for pressure increase.

fo. Open SOURCE SHUTOFF VALVE on LN_2 TANK PRESSURE panel.

fp. Vent pressure, indicated by any REG SUPPLY PRESS gage, by opening SHUTOFF and VENT valves on associated panel until gage returns to zero. Close SHUTOFF and VENT valves. On LN_2 TANK PRESSURE panel, turn PRESSURE REGULATOR to DECREASE to vent any indicated pressure.

fq. Check for zero leakage past PRESSURE REGULATOR on each of the following by observing REG SUPPLY PRESS gages for pressure increase:

(1) HIGH PRESSURE panel.

(2) MEDIUM PRESSURE panel.

(3) LOW PRESSURE panel.

(4) LN_2 TANK PRESSURE panel.

fr. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE until a minimum of 100 psi is indicated on gage on HIGH PRESSURE panel.

fs. Open SHUTOFF valve on HIGH PRESSURE panel. Slowly build up pressure as indicated on PRESSURE GAGE on PRESSURE/TEMPERATURE MONITOR panel until SYSTEM PRESSURIZED light comes on. Close SHUTOFF valve. If light does not come on within 25 and 75 psi, refer to paragraph 12-67 for adjustment.

ft. Open VENT valve on HIGH PRESSURE panel until SYSTEM PRESSURIZED light goes off. Close VENT valve. SYSTEM PRESSURIZED light goes off before zero is reached, as indicated on PRESSURE GAGE on PRESSURE/TEMPERATURE MONITOR panel.

fu. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE until a minimum of 100 psi is indicated on gage on MEDIUM PRESSURE panel.

fv. Slowly open SHUTOFF valve on MEDIUM PRESSURE panel. Build up pressure as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel until SYSTEM PRESSURIZED light comes on. Close SHUTOFF valve. If light does not come on within 25 and 75 psi, refer to paragraph 12-67 for adjustment.

fw. Open VENT valve on MEDIUM PRESSURE panel until SYSTEM PRESSURIZED light goes off. Close VENT valve. SYSTEM PRESSURIZED light goes off before zero is reached, as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

fx. Open SHUTOFF valve on LOW PRESSURE panel.

fy. Turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE until SYSTEM PRESSURIZED light comes on. If light does not come on within 25 and 75 psi, as indicated on gage on LOW PRESSURE panel, refer to paragraph 12-67 for adjustment.

fz. Turn PRESSURE REGULATOR on LOW PRESSURE panel to DECREASE until SYSTEM PRESSURIZED light goes off. Light goes off before zero is reached.

ga. Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

gb. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 20-25 psi is indicated on gage on LN_2 TANK PRESSURE panel. Wait one minute to permit system pressure to stabilize; then verify that SYSTEM PRESSURIZED light has not come on.

gc. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 70-75 psi is indicated on gage on LN_2 TANK PRESSURE panel. SYSTEM PRESSURIZED light comes on. A short wait may be necessary to permit system pressure to stabilize before light comes on.

gd. Depress PRESS TO VENT TANK switch-light and turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE for a minimum of 5 seconds. PRESS TO VENT TANK light comes on and system vents. Continue venting system for a minimum of 15 seconds after SYSTEM PRESSURIZED light has gone out. Depress PRESS TO VENT TANK switch-light. PRESS TO VENT TANK light goes off.

NOTE

Venting is maintained after SYSTEM PRESSURIZED light goes off to effect a sufficient decrease in pressure to make sure SYSTEM PRESSURIZED light will not come on when system pressure stabilizes. If SYSTEM PRESSURIZED light does come on, step gd must be repeated.

ge. Disconnect lines to LN_2 RETURN, LN_2 SUPPLY, and LN_2 VENT outlets at rear of test cell.

gf. Open SHUTOFF valves on MEDIUM PRESSURE and HIGH PRESSURE panels. SYSTEM PRESSURIZED light comes on.

gg. While listening for audible leakage, turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure until 4,900 to 5,000 psi is indicated on gage on HIGH PRESSURE panel and on PRESSURE gage on PRESSURE/TEMPERATURE MONITOR panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

gh. While listening for audible leakage, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure until 1,970 to 1,985 psi is indicated on gage on MEDIUM PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

gi. While listening for audible leakage, turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE. Slowly build up pressure until 150-155 psi is indicated on gage on LOW PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

gj. Check for zero leakage past VENT valve on PRESSURE/ΔP MONITOR panel by applying leak-test compound over LN_2 VENT outlet at rear of console. Make sure leak-test compound does not enter LN_2 VENT outlet.

gk. While listening for audible leakage, turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Slowly build up pressure until 1,185 to 1,215 psi is indicated on gage on LN_2 TANK PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

gl. Check for zero leakage past the LN_2 tank vent valve, LN_2 tank vent solenoid valve, and relief valve by applying leak-test compound over LN_2 VENT outlet at rear of console. If leakage exists, disassemble internal plumbing and determine which of the 3 components is faulty.

gm. Check for zero leakage past LN_2 return valve by applying leak-test compound over LN_2 RETURN outlet on rear of console. Make sure leak-test compound does not enter LN_2 RETURN outlet.

gn. Check for zero reverse leakage from LN_2 supply system check valve by applying leak-test compound over LN_2 SUPPLY outlet on rear of console. Make sure leak-test compound does not enter LN_2 SUPPLY outlet.

go. Install a pressure cap over LN_2 RETURN outlet on rear of console.

gp. Open LN_2 return and LN_2 supply valves.

gq. Apply leak-test compound to all tubing connections and vent valve and relief valve outlets on the following panels: (Also check tubing connections on interconnecting lines between any 2 panels. No leakage is allowable. If leakage exists on tubing connections, vent pressure and correct leakage before proceeding with test.)

(1) PNEU SOURCE CONTROL.

(2) SYSTEM SUPPLY.

(3) HIGH PRESSURE.

(4) MEDIUM PRESSURE.

(5) LOW PRESSURE.

(6) LN_2 TANK PRESSURE.

(7) PRESSURE/TEMPERATURE MONITOR.

(8) PRESSURE/ΔP MONITOR (TEST CELL MONITOR PRESSURE gage only).

(9) 0-6000 PSIG UTILITY INLETS.

(10) LN_2 system under test cell.

gr. Check for zero leakage past PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel by observing gage on PRESSURE/FLOW MONITOR panel for pressure increase.

gs. Move PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until 960-980 psi . . indicated on gage on MEDIUM PRESSURE panel and on TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel.

gt. Open all valves on PRESSURE/FLOW MONITOR panel. Gage on PRESSURE/FLOW MONITOR panel indicates 960-980 psi.

gu. Apply leak-test compound to all tubing connections and relief valve outlets on PRESSURE/FLOW MONITOR panel. No leakage is allowable. If leakage exists on tubing connections, vent pressure and correct leakage before proceeding with test. Correction of minor leakage from relief valve outlets may be delayed until completion of test.

gv. Close LN_2 supply valve inside console and below test cell.

gw. Increase pressure in LN_2 system in 25-psi increments by turning PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Wait one minute between each 25-psi increase, to allow system pressure to stabilize. Continue increasing pressure until relief valve opens. Relief valve opens between 1,275 and 1,375 psi, as indicated on gage on LN_2 TANK PRESSURE panel.

gx. Close LN_2 TANK SHUTOFF and SOURCE SHUTOFF valves on LN_2 TANK PRESSURE panel.

gy. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE until associated gage indicates zero.

gz. Check for zero leakage past LN_2 TANK SHUTOFF valve by checking vent outlet of PRESSURE REGULATOR on LN_2 TANK PRESSURE panel for evidence of leakage.

ha. Depress PRESS TO VENT TANK switch-light on LN_2 TANK PRESSURE panel. PRESS TO VENT TANK light comes on.

hb. Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

hc. Close SHUTOFF valve on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels.

hd. Open VENT valves on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels.

he. When SYSTEM PRESSURIZED light goes off, wait a minimum of 15 seconds; then depress PRESS TO VENT TANK switch-light on LN_2 TANK PRESSURE panel. PRESS TO VENT TANK light goes off.

hf. Check for zero leakage past SHUTOFF valve on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels by applying leak-test compound to outlet ports of VENT valves.

hg. Close LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

hh. Open SOURCE SHUTOFF valve on LN_2 TANK PRESSURE panel.

hi. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until 1,185 to 1,215 psi is indicated on associated REG SUPPLY PRESS gage.

hj. Close gage isolation valves inside console and accessible through right-hand access door, for the following panels:

(1) HIGH PRESSURE.

(2) MEDIUM PRESSURE.

(3) LOW PRESSURE.

(4) LN_2 TANK PRESSURE.

hk. Turn PRESSURE REGULATOR on the following panels to DECREASE until all audible venting of pressure has ceased, and release PRESSURE REGULATOR:

(1) HIGH PRESSURE.

(2) MEDIUM PRESSURE.

(3) LOW PRESSURE.

(4) LN_2 TANK PRESSURE.

hl. Check for zero leakage past gage isolation valves by observing REG SUPPLY PRESS gages on the following panels:

(1) HIGH PRESSURE.

(2) MEDIUM PRESSURE.

(3) LOW PRESSURE.

(4) LN_2 TANK PRESSURE.

hm. Open the 4 closed gage isolation valves.

hn. Unlock and open test cell cover.

ho. Disassemble existing test setup and reconnect as necessary to accomplish the following: (Do not remove cryogenic hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to 0-1000 PSIG MON INLET, DNSTM INLET 0-60 ΔP, and UPSTM INLET 0-60 ΔP.

(2) PNEU OUTLET MED PRESS connected to 0-600 PSIG MON "A" INLET and 0-600 PSIG MON "B" INLET outlets. (To prevent interference with test cell cover when cover is in closed position, use an elbow fitting in 0-600 PSIG MON "B" INLET.)

hp. Close and lock test cell cover.

hq. Close all valves on PRESSURE/FLOW MONITOR panel.

hr. Close VENT valves on HIGH PRESSURE and MEDIUM PRESSURE panels.

hs. Open SHUTOFF valves on HIGH PRESSURE and MEDIUM PRESSURE panels.

ht. While listening for audible leakage, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure until 560-590 psi is indicated on gage on MEDIUM PRESSURE panel and on gages on LOW PRESSURE MONITOR panel. SYSTEM PRESSURIZED light comes on. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

hu. While listening for audible leakage, turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure until 2,950 to 3,000 psi is indicated on gage on HIGH PRESSURE panel. If audible leakage exists, vent pressure and correct leakage before proceeding with test.

hv. Apply leak-test compound to all tubing connections, vent valve, and relief valve outlets on LOW PRESSURE MONITOR panel and PRESSURE DIFFERENTIAL system on PRESSURE/ΔP MONITOR panel. No leakage is allowable. If leakage exists on tubing fittings, vent pressure and correct leakage before proceeding with test. Correction of minor leakage from vent or relief valve outlets may be delayed until completion of test.

hw. Turn PRESSURE REGULATORS on MEDIUM and HIGH PRESSURE panels to DECREASE and vent pressures downstream of these regulators. SYSTEM PRESSURIZED light goes off and MEDIUM and HIGH PRESSURE gages and gages on LOW PRESSURE MONITOR panel indicate zero.

hx. Turn off facility helium supply.

hy. Open SYST VENT valve on SYSTEM SUPPLY panel until SYST SUPPLY PRESS gage indicates zero. Close valve.

hz. Close NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

ia. Turn on facility gaseous nitrogen supply. Facility gaseous nitrogen pressure is indicated on nitrogen SOURCE PRESS gage on PNEU SOURCE CONTROL panel. A minimum of 5,000-psi is required.

ib. Check for zero leakage past NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel by observing gage on SYSTEM SUPPLY panel for pressure increase.

ic. Open NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel. Facility pressure is indicated on SYST SUPPLY PRESS gage.

id. Check for zero reverse leakage of check valve which isolates nitrogen source pressure from helium supply system by observing helium SOURCE PRESS gage on PNEU SOURCE CONTROL panel for pressure increase.

ie. Close HELIUM SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

if. Open PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel.

ig. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on HIGH PRESSURE panel until 1,050-psig relief valve on PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 998 to 1,102 psig. When relief valve opens, turn PRESSURE REGULATOR to DECREASE and vent all pressure indicated on HIGH PRESSURE and PRESSURE/FLOW MONITOR panels. Gages on HIGH PRESSURE and PRESSURE/FLOW MONITOR panels indicate zero, SYSTEM PRESSURIZED light goes off, and relief valve closes.

ih. Move power switch on DIGITAL VOLTMETER to ON. DIGITAL VOLTMETER is energized and is being warmed up for later use.

ii. Unlock and open test cell cover.

ij. Reconnect test setup as necessary to accomplish the following: (Do not remove hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to 0-2000 PSIG MON INLET and 0-6000 PSIG MON INLET.

(2) PNEU OUTLET MED PRESS connected to HIGH FLOW INLET.

(3) PNEU OUTLET LOW PRESS connected to 0-600 PSIG MON "A" INLET.

(4) HIGH FLOW OUTLET connected to 0-600 PSIG MON "B" INLET.

ik. Close and lock test cell cover.

il. Close PRESSURE MONITOR INLET valve on PRESSURE/FLOW MONITOR panel.

im. Open SHUTOFF valve on LOW PRESSURE panel.

in. Close VENT valve on LOW PRESSURE panel.

io. Close gage isolation valve, inside console, for gage on LOW PRESSURE panel.

ip. Turn PRESSURE REGULATOR on LOW PRESSURE panel to INCREASE. Slowly build up pressure as indicated on PRESSURE MONITOR "A" gage on LOW PRESSURE MONITOR panel until 170-psig relief valve on LOW PRESSURE panel opens. SYSTEM PRESSURIZED light comes on. Relief valve opens at 162-178 psig. When relief valve opens, turn PRESSURE REGULATOR on LOW PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

iq. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on MEDIUM PRESSURE panel until 1,100-psig relief valve in high-flow system of PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 1,045 to 1,155 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

ir. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel as necessary until 950 to 1,000 psi is indicated on gage on MEDIUM PRESSURE panel.

is. Check for zero leakage past SHUTOFF valve between HIGH FLOW SHUTOFF and PRESSURE MONITOR INLET valves on PRESSURE/FLOW MONITOR panel by observing pressure gage on PRESSURE/FLOW MONITOR panel for pressure increase.

it. Check for zero leakage past HIGH FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel by observing PRESSURE MONITOR "B" gage on LOW PRESSURE MONITOR panel for pressure increase.

iu. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on PRESSURE gage on PRESSURE/TEMPERATURE MONITOR panel until 2,100-psig relief valve in TEST CELL MONITOR PRESSURE system opens. TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel also indicates pressure and may go beyond range which is not detrimental to gage. Relief valve opens at 1,995 to 2,205 psig. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

iv. Prepare DIGITAL VOLTMETER (turned on in step ih) for frequency measurements. (Refer to paragraph 12-30.) If it is at operating temperature, the warm-up period required by adjustment procedure may be ignored. Frequency measurement cannot be obtained until step ix is performed.

iw. Depress switch-lights 5 and 6. Upper lights 5 and 6 go on.

ix. Open LOW PRESSURE MONITOR "B" VENT valve on LOW PRESSURE MONITOR panel.

iy. Check operation of high-flow transducer by slowly opening HIGH FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel until a minimum of kc-000.100 is indicated on DIGITAL VOLTMETER. Close HIGH FLOW SHUTOFF valve.

iz. Close LOW PRESSURE MONITOR "B" VENT valve on LOW PRESSURE MONITOR panel.

ja. Move PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until a maximum of 500 psi is indicated on gage on MEDIUM PRESSURE panel.

jb. Open HIGH FLOW SHUTOFF valve and SHUTOFF valve between PRESSURE MONITOR INLET and HIGH FLOW SHUTOFF valves on PRESSURE/FLOW MONITOR panel. Pressure gage on PRESSURE/FLOW MONITOR panel and MONITOR "B" pressure gage on LOW PRESSURE MONITOR panel indicate a maximum of 500 psi.

jc. Close gage isolation valve, inside console, for MONITOR "B" gage on LOW PRESSURE MONITOR panel.

jd. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE and slowly build up pressure as indicated on gage on MEDIUM PRESSURE panel and pressure gage on PRESSURE/FLOW MONITOR panel until 630-psig relief valve in MONITOR "B" system in LOW PRESSURE MONITOR panel opens. Relief valve opens at 598-662 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

je. Turn PRESSURE REGULATOR on HIGH PRESSURE, MEDIUM PRESSURE, and LOW PRESSURE panels to DECREASE to vent all pressure. SYSTEM PRESSURIZED light goes off. MONITOR "B" pressure gage indicates pressure locked in by closed gage isolation valve.

jf. Check for zero leakage past gage isolation valve for MONITOR "B" gage by observing MONITOR "B" gage for pressure decrease.

jg. Open gage isolation valve for MONITOR "B" gage. MONITOR "B" gage pressure decreases to zero.

jh. Unlock and open test cell cover.

ji. Reconnect test setup as necessary to accomplish the following: (Do not remove hand valves.)

(1) PNEU OUTLET HIGH PRESS connected to LOW FLOW INLET and to 0-2000 PSIG MON INLET.

(2) LOW FLOW OUTLET connected to 0-600 PSIG MON "A" INLET.

(3) PNEU OUTLET MEDIUM PRESS connected to 0-6000 PSIG MON INLET.

jj. Close and lock test cell cover.

jk. Close gage isolation valve for gage on MEDIUM PRESSURE panel.

jl. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on PRESSURE gage on PRESSURE/TEMPERATURE MONITOR panel until 2,100-psig relief valve in MEDIUM PRESSURE panel opens. SYSTEM PRESSURIZED light comes on. Relief valve opens at 1,995 to 2,205 psig. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

jm. Close the 2 opened valves on PRESSURE/FLOW MONITOR panel. All 5 valves on this panel are now closed.

jn. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel until 1,100-psig relief valve in low-flow system of PRESSURE/FLOW MONITOR panel opens. Relief valve opens at 1,045 to 1,155 psig. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until relief valve closes. Release PRESSURE REGULATOR.

jo. Turn PRESSURE REGULATOR on HIGH PRESSURE panel as necessary until 950 to 1,000 psi is indicated on gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel.

jp. Check for zero leakage past SHUTOFF valve between LOW FLOW SHUTOFF and PRESSURE MONITOR INLET valves on PRESSURE/FLOW MONITOR panel by observing pressure gage on PRESSURE/FLOW MONITOR panel for pressure increase.

jq. Check for zero leakage past LOW FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel by observing PRESSURE MONITOR "A" gage on LOW PRESSURE MONITOR panel for pressure increase.

jr. Depress switch-lights 5 and 6. Upper lights 5 and 6 go off.

js. Open LOW PRESSURE MONITOR "A" VENT valve on LOW PRESSURE MONITOR panel.

jt. Check operation of low-flow transducer by slowly opening LOW FLOW SHUTOFF valve on PRESSURE/FLOW MONITOR panel until kc-001.000 is indicated on DIGITAL VOLTMETER. Close LOW FLOW SHUTOFF valve. Move toggle switch on DIGITAL VOLTMETER down. DIGITAL VOLTMETER is deenergized.

ju. Close LOW PRESSURE MONITOR "A" VENT valve on LOW PRESSURE MONITOR panel.

jv. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE until 575-600 psi is indicated on gage on HIGH PRESSURE panel and TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel.

jw. Open LOW FLOW SHUTOFF valve and SHUTOFF valve between PRESSURE MONITOR INLET and LOW FLOW SHUTOFF valves on PRESSURE/FLOW MONITOR panel. Pressure gage on PRESSURE/FLOW MONITOR panel and MONITOR "A" pressure gage on LOW PRESSURE MONITOR panel indicate 575-600 psi.

jx. Close gage isolation valve, inside console, for MONITOR "A" gage on LOW PRESSURE MONITOR panel.

jy. Turn PRESSURE REGULATOR on HIGH PRESSURE panel to INCREASE. Slowly build up pressure, as indicated on gage on HIGH PRESSURE panel, TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel, and gage on PRESSURE/FLOW MONITOR panel until 630-psig relief valve in MONITOR "A" system in LOW PRESSURE MONITOR panel opens. Relief valve opens at 598-662 psig. Opening pressure is monitored on gage on PRESSURE/FLOW MONITOR

panel. When relief valve opens, turn PRESSURE REGULATOR on HIGH PRESSURE panel to DECREASE and vent pressure as indicated by TEST CELL MONITOR PRESSURE gage on PRESSURE/ΔP MONITOR panel and gage on PRESSURE/FLOW MONITOR panel.

jz. Check for zero leakage past gage isolation valve for MONITOR "A" gage by observing MONITOR "A" gage for pressure decrease.

ka. Open gage isolation valve for MONITOR "A" gage. MONITOR "A" gage pressure decreases to zero.

kb. Open gage isolation valve, inside console, for gage on MEDIUM PRESSURE panel. Gage indicates approximately same pressure as indicated on PRESSURE/TEMPERATURE MONITOR panel.

kc. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE. Vent pressure as indicated on gages on PRESSURE/TEMPERATURE MONITOR MEDIUM PRESSURE panels. SYSTEM PRESSURIZED light goes out.

kd. Unlock and open test cell cover.

ke. Disassemble test setup and reconnect as necessary to accomplish the following:

(1) Cryogenic hand valve on LN_2 standpipe connected to 0-2000 PSIG MON INLET. (Use hose left in test cell [step ez] and a second cryogenic hose to effect hook-up.)

(2) LN_2 RETURN in test cell connected to 0-60^ PSIG MON "A" INLET.

(3) PNEU OUTLET MED PRESS connected to LN_2 SUPPLY and LN_2 RETURN outlets at rear of console. (To permit closing test cell cover, utilize 0-6000 PSIG UTILITY INLETS to supply pressure to outlets at rear of console.)

kf. Close LN_2 return valve inside console and below test cell.

kg. Close and lock test cell cover.

kh. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to INCREASE. Slowly build up pressure as indicated on REG SUPPLY PRESS gage on MEDIUM PRESSURE panel until 1,325-psig relief valve in LN_2 supply system opens. Relief valve opens at 1,259 to 1,391 psi, as indicated on gage on MEDIUM PRESSURE panel. When relief valve opens, turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE until relief valve closes.

ki. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel as necessary until 1,150 to 1,200 psi is indicated on gage on MEDIUM PRESSURE panel.

kj. Check for zero reverse leakage of check valve in LN_2 return system by observing MONITOR "A" gage on LOW PRESSURE MONITOR panel for pressure increase.

kk. Wait 10 minutes, then check for zero leakage past LN_2 SUPPLY valve by observing TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel for pressure increase.

NOTE

The waiting period is necessary due to the large volume of the liquid nitrogen storage tank.

kl. Turn PRESSURE REGULATOR on MEDIUM PRESSURE panel to DECREASE and vent pressure indicated on gage on MEDIUM PRESSURE panel.

km. Vent trapped pressure upstream of check valve in LN_2 supply line by opening LN_2 SUPPLY and LN_2 tank vent valves inside console and below test cell.

kn. Unlock and open test cell cover.

ko. Disconnect and remove test setup, including connections to rear of console, but do not remove connection between LN_2 standpipe and 0-2000 PSIG MON INLET.

kp. Open hand valve connected to tee at top of LN_2 storage tank.

kq. Close and lock test cell cover.

kr. Open VENT valve on PRESSURE/Δ P MONITOR panel.

ks. Connect facility lines to LN_2 SUPPLY and LN_2 RETURN connections on rear of console.

kt. Supply facility helium pressure to console. Facility pressure is indicated on helium SOURCE PRESS gage on PNEU SOURCE CONTROL panel. A minimum of 1,400 psig is required for this test.

ku. Supply facility liquid nitrogen to console and fill storage tank until 15-18 inches is indicated on LN_2 LEVEL gage. When required level is reached, close LN_2 SUPPLY and LN_2 tank vent valves, inside console and below test cell, and VENT valve on PRESSURE/Δ P MONITOR panel.

WARNING

Do not allow any part of the body to come in contact with frozen or extremely cold material. Human tissue will freeze upon contact, causing serious, permanent injury.

kv. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until REG SUPPLY PRESS gage indicates 1,200 ±40 psi.

kw Open LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

kx. Inspect liquid nitrogen tank system connections for leakage. No audible leakage is allowable.

ky. If leakage is found at line connections or relief valve requires adjustment, drain LN_2 storage tank, depressurize pneumatic system, and allow system to return to ambient temperature before tightening connections or adjusting relief valve.

WARNING

Loosening or tightening connections while system is pressurized or at a cryogenic temperature can result in serious injury to personnel and damage to equipment.

kz. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE. Slowly build up pressure as indicated on gage on LN_2 TANK PRESSURE panel and on TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel until 1,325-psig relief valve in LN_2 system opens. Relief valve opens at 1,259 to 1,391 psi, as indicated on TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel. When relief valve opens, turn PRESSURE REGULATOR on LN_2 PRESSURE PANEL to DECREASE until relief valve closes. Release regulator.

la. Dispose of liquid nitrogen remaining in LN_2 storage tank (approximately 2 gallons for each inch shown on LN_2 LEVEL gage) either by returning it to facility supply or venting it to atmosphere. To return liquid nitrogen to facility supply, perform steps lb through ld. To vent it to atmosphere, proceed to step le.

lb. Prepare facility to accept return of liquid nitrogen.

lc. Open LN_2 return valve inside console and below test cell.

ld. Increase pressure in LN_2 system to overcome facility supply pressure. Pressure increase can be accomplished by natural boiloff of liquid or by turning PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to INCREASE until required pressure is reached. Monitor LN_2 system pressure on TEST CELL MONITOR PRESSURE gage on PRESSURE/Δ P MONITOR panel. When liquid has been depleted as indicated on LN_2 LEVEL gage, close LN_2 return valve.

1e. Open LN_2 tank vent valve inside console and below test cell.

1f. Close SOURCE SHUTOFF and LN_2 TANK SHUTOFF valve on LN_2 TANK PRESSURE panel.

1g. Turn PRESSURE REGULATOR on LN_2 TANK PRESSURE panel to DECREASE until gage on LN_2 TANK PRESSURE panel indicates zero. Release regulator.

1h. Close NITROGEN SOURCE SHUTOFF valve on PNEU SOURCE CONTROL panel.

1i. Open SYST VENT valve on SYSTEM SUPPLY panel.

1j. Close SHUTOFF valves on LOW PRESSURE, MEDIUM PRESSURE, and HIGH PRESSURE panels.

1k. Open all closed gage isolation valves.

1l. Close opened valves on PRESSURE/FLOW MONITOR panel.

1m. Close facility nitrogen and helium pressure supplies. Nitrogen and helium SOURCE PRESS gages indicate zero.

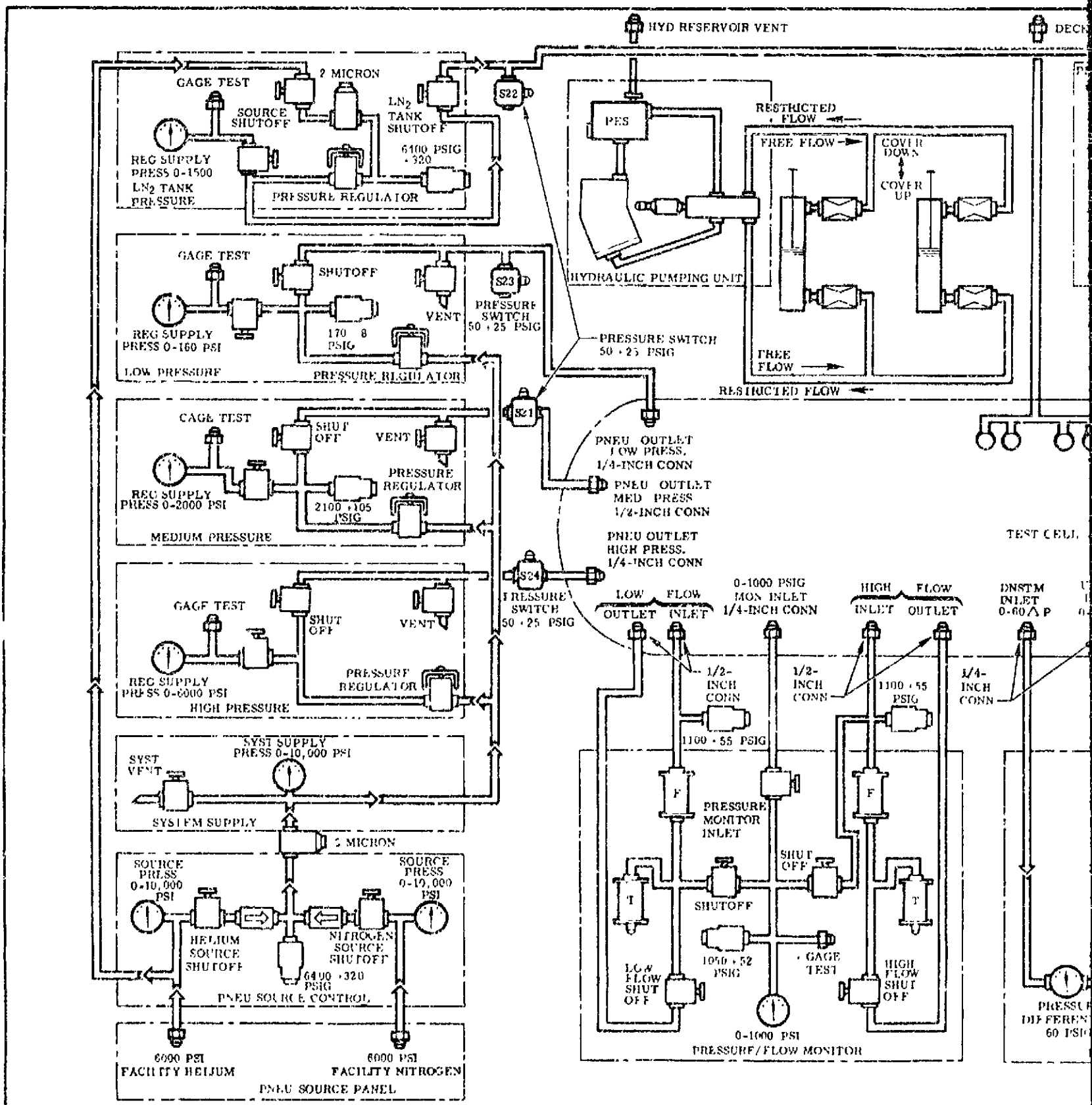
1n. When all pressure has been vented and SYSTEM PRESSURIZED light is out, close SYST VENT valve on SYSTEM SUPPLY panel.

1o. Unlock and open test cell cover.

1p. Deenergize circuit breakers on POWER DISTRIBUTION panel.

1q. When LN_2 storage tank has been depleted of all liquid nitrogen, as indicated by melting of frost on lines, close LN_2 TANK VENT valve and disassemble test setup. Up to 8 hours may be required to boil off a half-full storage tank.

1r. Energize circuit breakers on POWER DISTRIBUTION panel, close and lock test cell cover, and deenergize circuit breakers on POWER DISTRIBUTION panel.


HYD RESERVOIR VENT
DECK
GAGE TEST
2 MICRON
SOURCE SHUTOFF
LN_2 TANK SHUTOFF
S22
REG SUPPLY PRESS 0-1500 LN_2 TANK PRESSURE
6100 PSIG ±320
PRESSURE REGULATOR
PES
RESTRICTED FLOW
FREE FLOW
COVER DOWN
COVER UP
HYDRAULIC PUMPING UNIT
GAGE TEST
SHUTOFF
VENT
S23
PRESSURE SWITCH 50 ± 25 PSIG
REG SUPPLY PRESS 0-160 PSI
170 ± 8 PSIG
LOW PRESSURE
PRESSURE REGULATOR
PRESSURE SWITCH 50 ± 25 PSIG
FREE FLOW
RESTRICTED FLOW
GAGE TEST
SHUT OFF
VENT
S21
PRESSURE REGULATOR
REG SUPPLY PRESS 0-2000 PSI
2100 ± 105 PSIG
MEDIUM PRESSURE
PNEU OUTLET LOW PRESS. 1/4-INCH CONN
PNEU OUTLET MED PRESS 1/4-INCH CONN
PNEU OUTLET HIGH PRESS. 1/4-INCH CONN
TEST CELL
GAGE TEST
SHUT OFF
VENT
S24
PRESSURE SWITCH 50 ± 25 PSIG
REG SUPPLY PRESS 0-6000 PSI
PRESSURE REGULATOR
HIGH PRESSURE
LOW FLOW OUTLET
FLOW INLET
0-1000 PSIG MON INLET 1/4-INCH CONN
HIGH FLOW INLET
FLOW OUTLET
DNSTM INLET 0-60 Δ P
SYST SUPPLY PRESS 0-10,000 PSI
SYST VENT
SYSTEM SUPPLY
2 MICRON
1/2-INCH CONN
1/2-INCH CONN
1100 ± 55 PSIG
1/4-INCH CONN
1100 ± 55 PSIG
F
F
PRESSURE MONITOR INLET
SOURCE PRESS 0-10,000 PSI
SOURCE PRESS 0-10,000 PSI
SHUT OFF
T
T
SHUTOFF
HELIUM SOURCE SHUTOFF
NITROGEN SOURCE SHUTOFF
1050 ± 52 PSIG
GAGE TEST
6400 ± 320 PSIG
LOW FLOW SHUT OFF
HIGH FLOW SHUT OFF
PNEU SOURCE CONTROL
0-1000 PSI
PRESSURE/FLOW MONITOR
6000 PSI FACILITY HELIUM
6000 PSI FACILITY NITROGEN
PNEU SOURCE PANEL

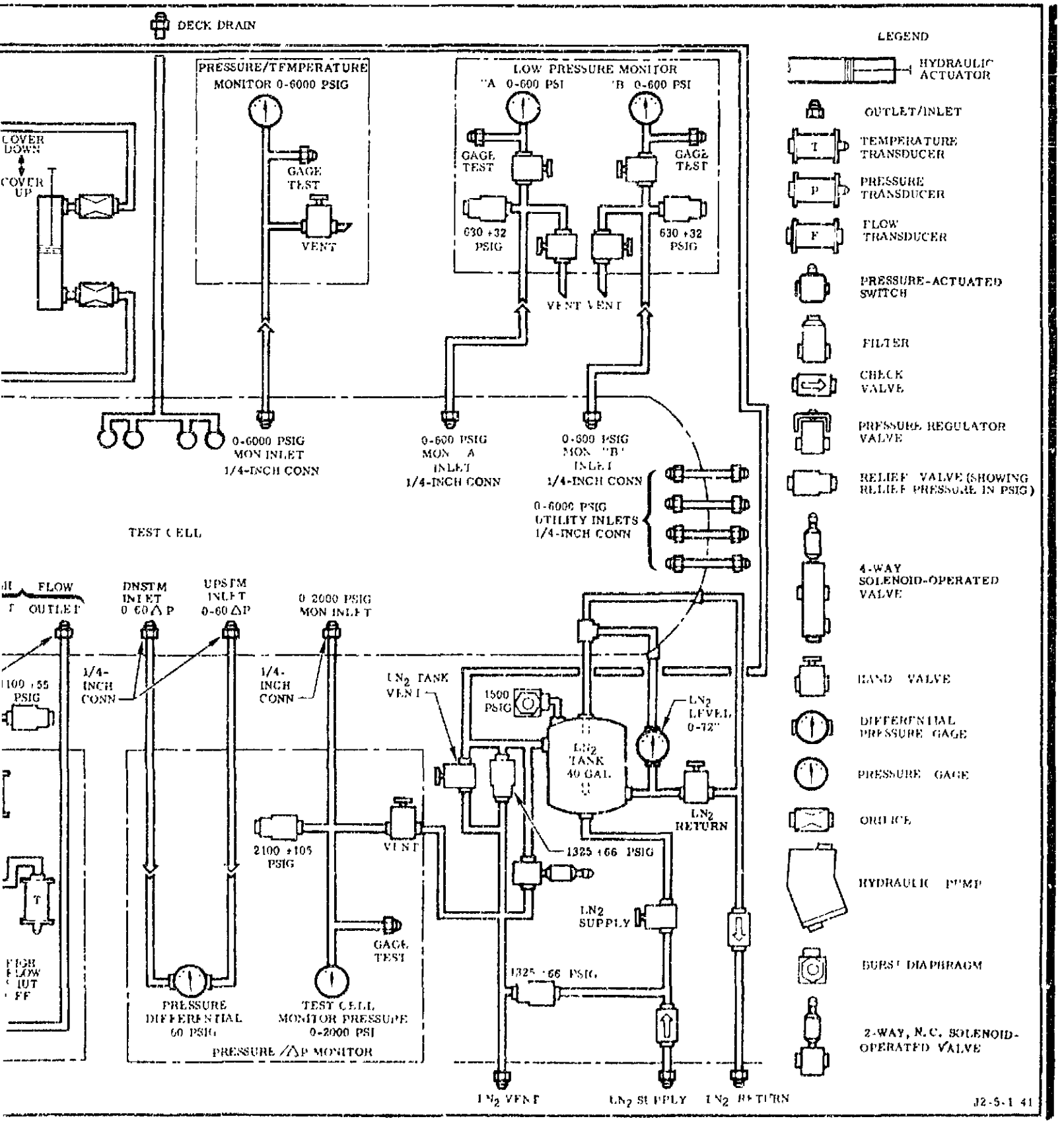
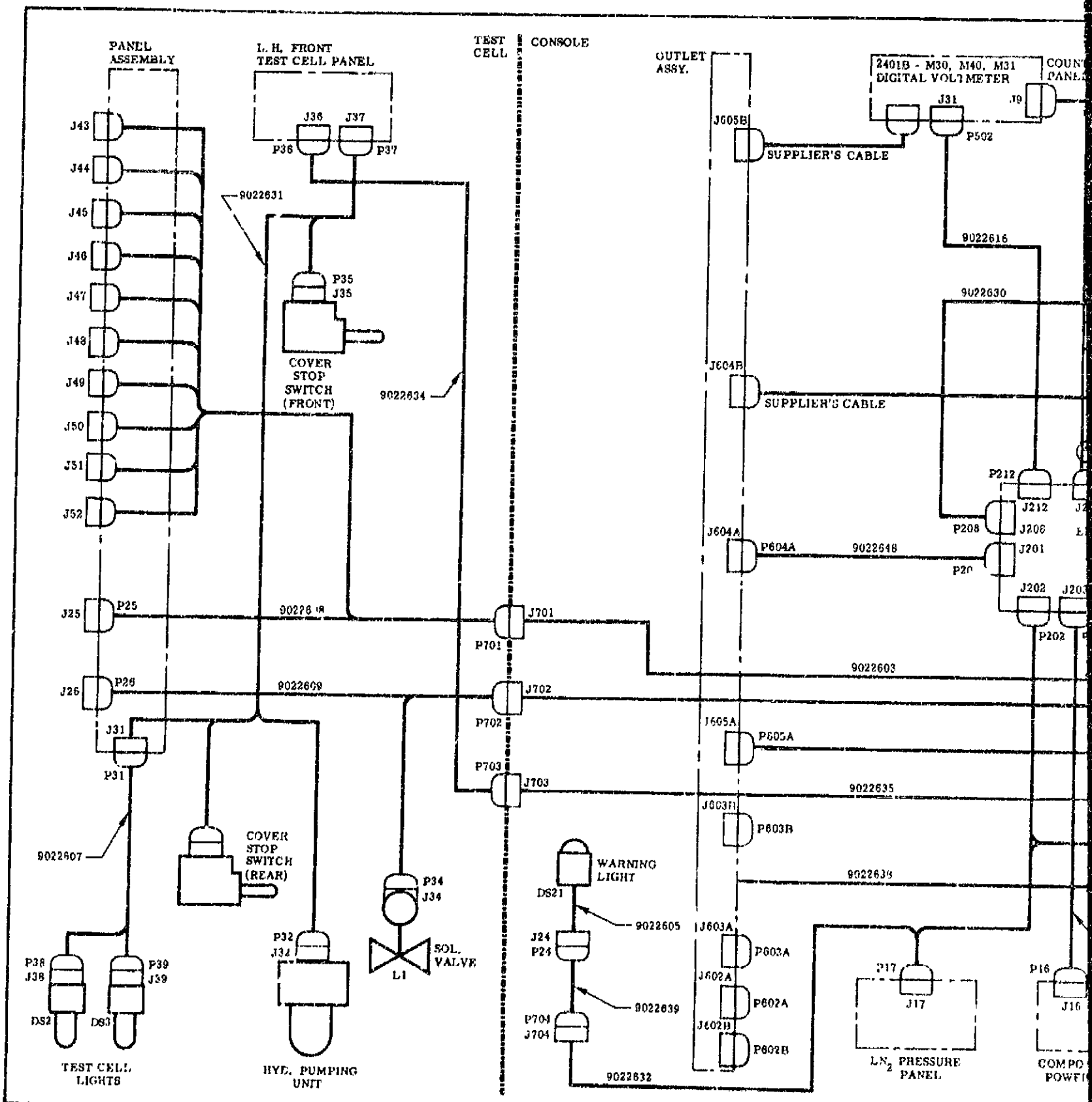


Figure 12-8. Pneumatic Schematic


PANEL ASSEMBLY
L. H. FRONT TEST CELL PANEL
TEST CELL CONSOLE
OUTLET ASSY.
2401B - M30, M40, M31 DIGITAL VOLTMETER
J43
J44
J45
J46
J47
J48
J49
J50
J51
J52
J36
J37
P36
P37
9022631
P35
J35
COVER STOP SWITCH (FRONT)
9022634
J605B
SUPPLIER'S CABLE
P502
J31
9022616
9022630
J604B
SUPPLIER'S CABLE
P212
J212
P208
J208
J604A
P604A
9022648
J201
P20
J202
P202
J25
P25
9022608
J701
P701
9022603
J26
P26
9022609
J702
P702
J605A
P605A
J31
P31
P703
J703
9022635
J603B
P603B
9022607
COVER STOP SWITCH (REAR)
P34
J34
SOL. VALVE
L1
WARNING LIGHT
DS21
9022636
9022605
J24
P24
J603A
P603A
J602A
P602A
J602B
P602B
P704
J704
9022639
9022632
P38
J38
P39
J39
DS2
DS3
TEST CELL LIGHTS
P32
J32
HYD. PUMPING UNIT
P17
J17
LN2 PRESSURE PANEL
P16
J16

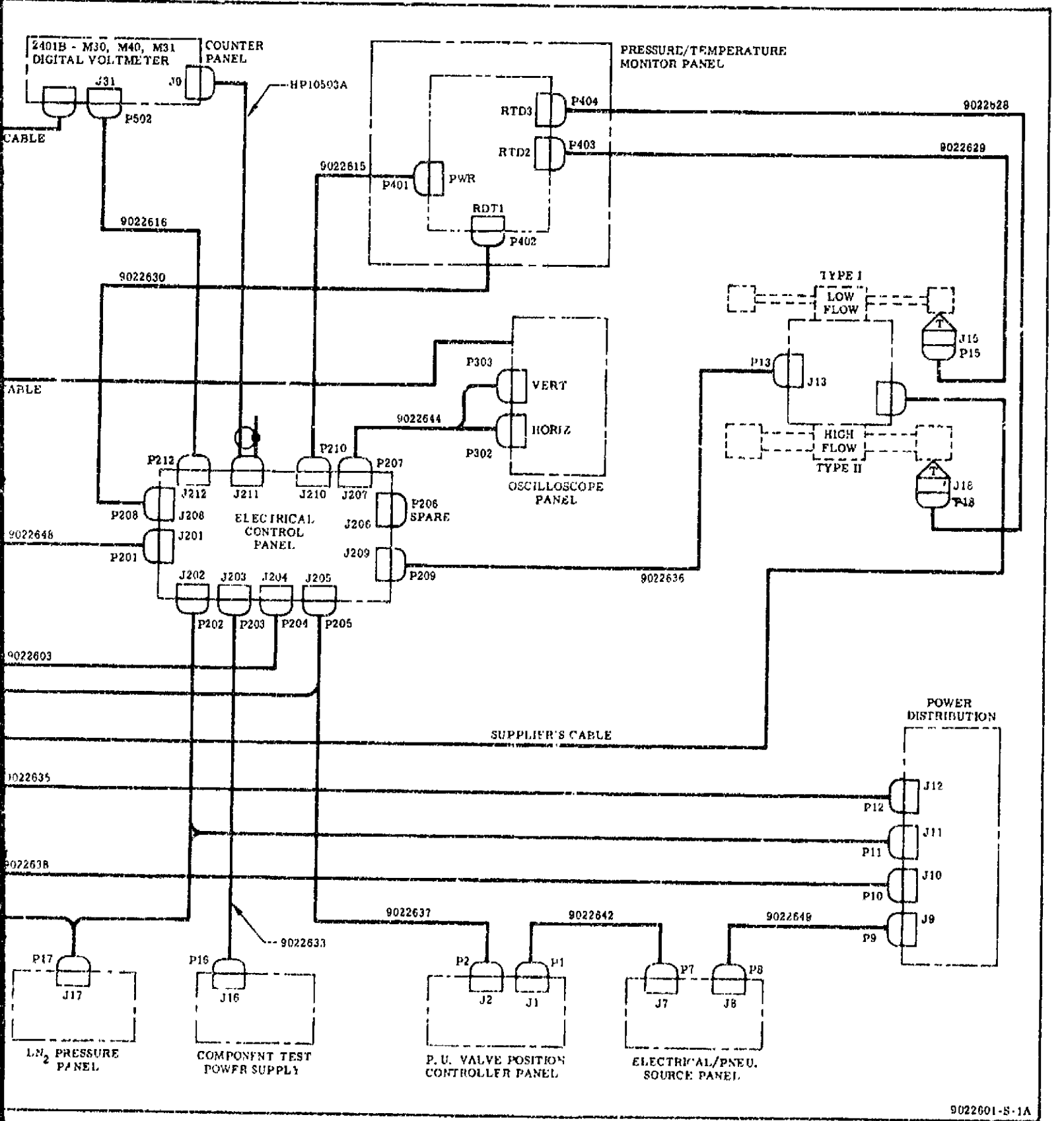


Figure 12-9. Electrical Block Diagram

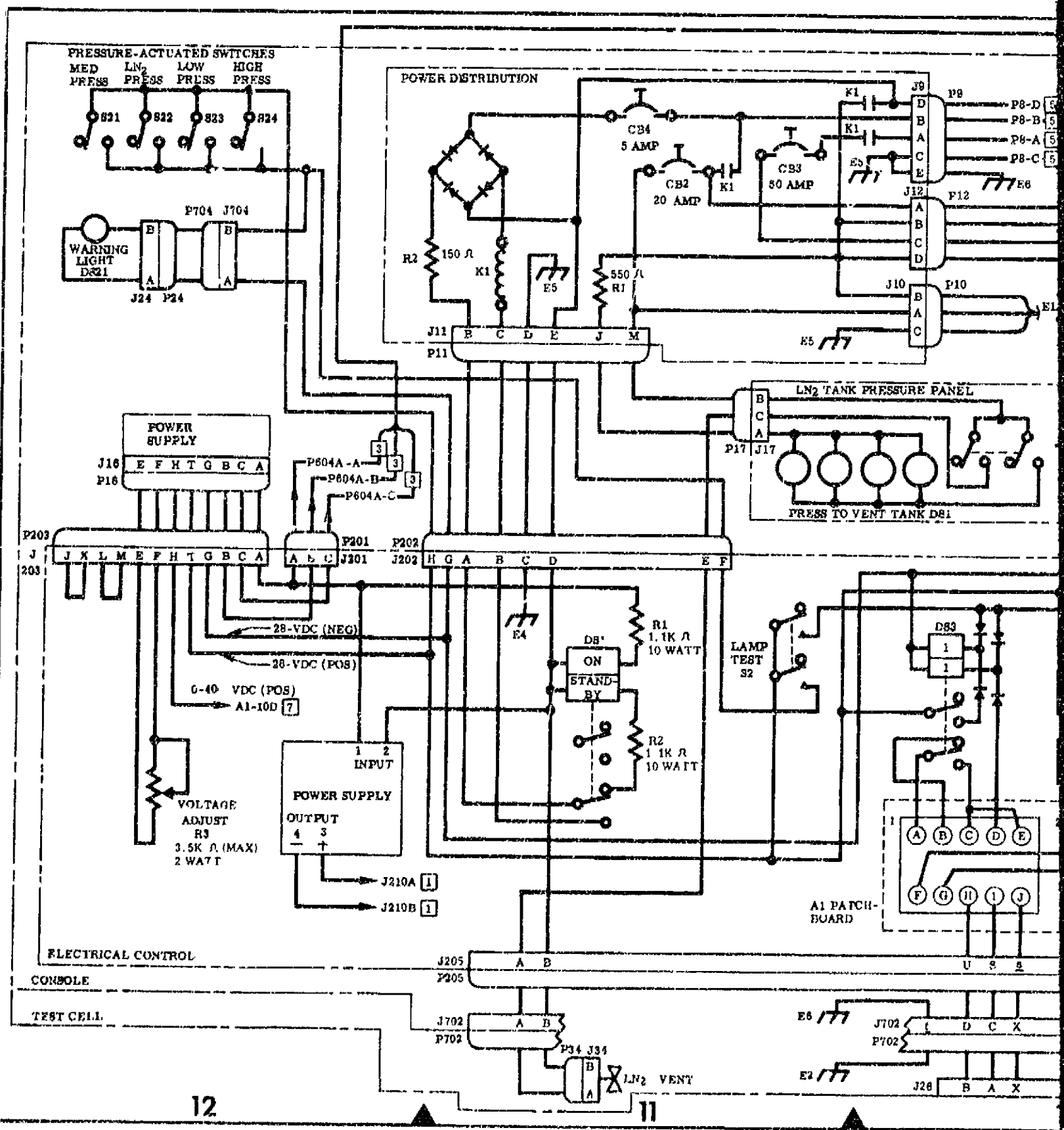
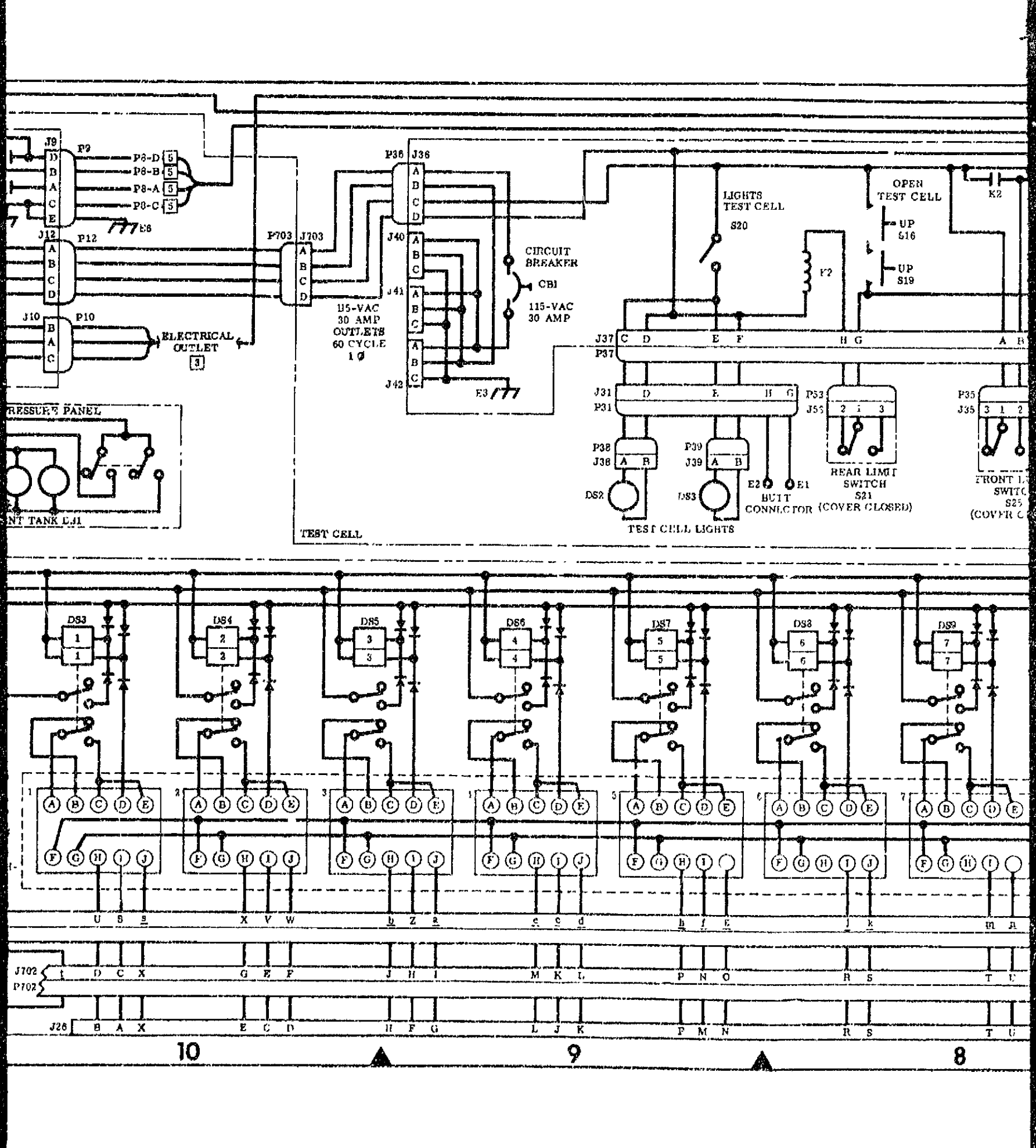
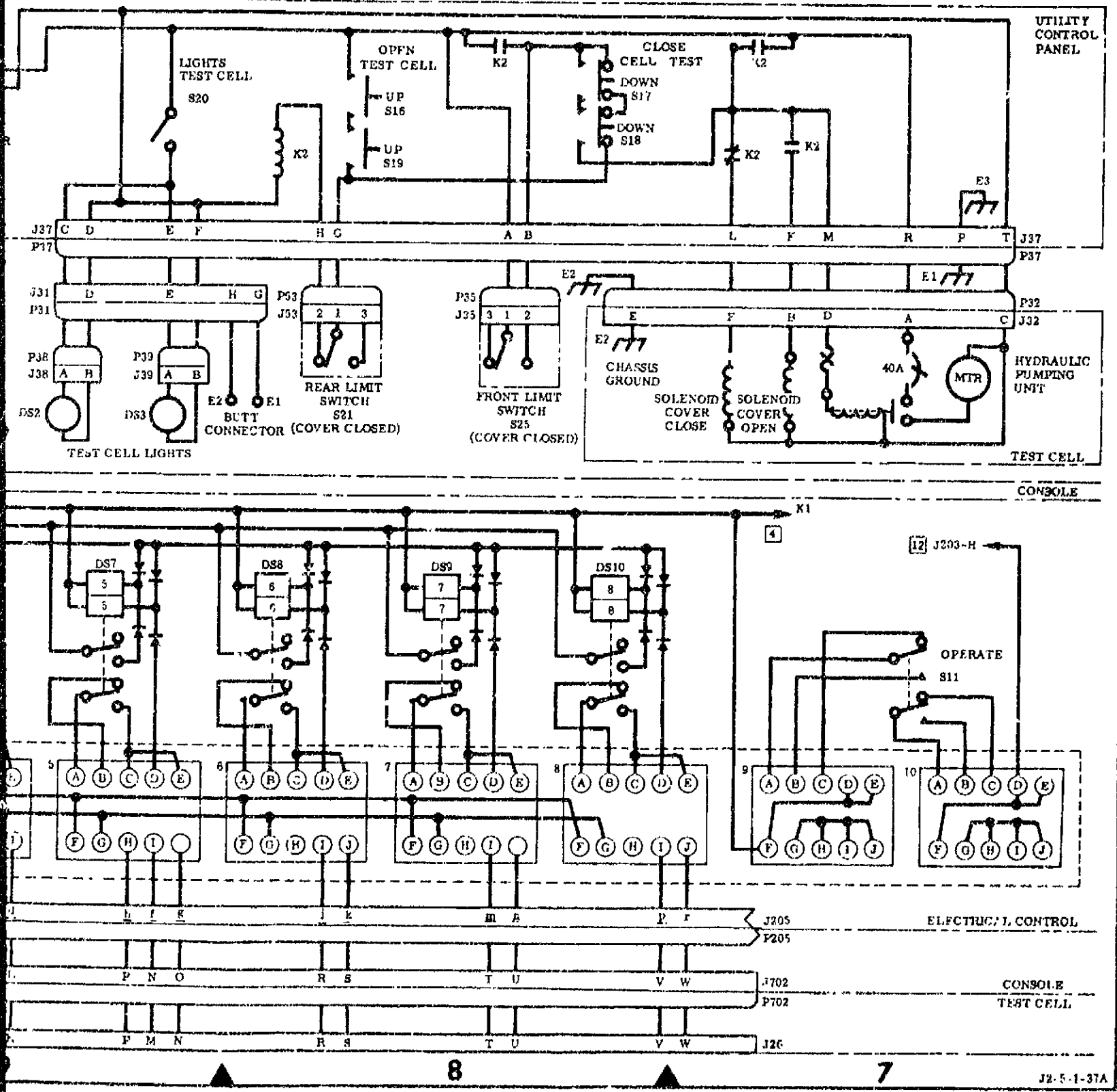
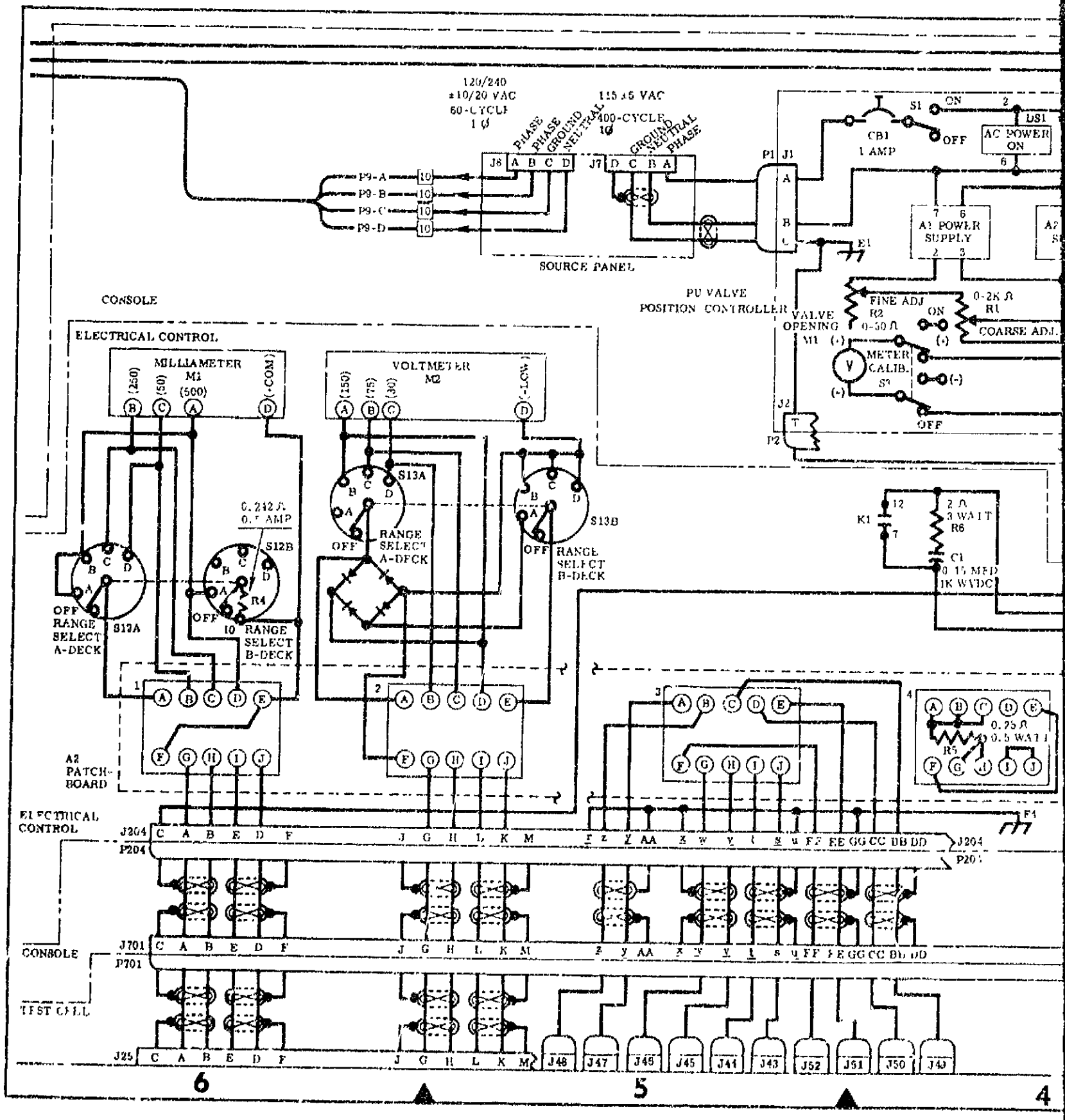


Figure 12-10. Electrical Schematic (Sheet 1 of 2)


J9
P9
P8-D
P8-B
P8-A
P8-C
E8
J12
P12
J10
P10
ELECTRICAL OUTLET
P703
J703
P36
J36
J40
J41
J42
115-VAC 30 AMP OUTLETS 60 CYCLE 1 Ø
CIRCUIT BREAKER
CB1
115-VAC 30 AMP
E3
LIGHTS TEST CELL
S20
OPEN TEST CELL
UP S16
UP S19
K2
K2
J37
P37
J31
P31
P38
J38
P39
J39
DS2
DS3
E2
E1
BUTT CONNECTOR
P53
J53
REAR LIMIT SWITCH S21 (COVER CLOSED)
P35
J35
FRONT LIMIT SWITCH S25 (COVER CLOSED)
TEST CELL LIGHTS
TEST CELL
DS3
DS4
DS5
DS6
DS7
DS8
DS9
J702
P702
J26


UTILITY CONTROL PANEL
LIGHTS TEST CELL
S20
OPEN TEST CELL
UP S16
UP S19
K2
CLOSE CELL TEST
DOWN S17
DOWN S18
E3
J37 C D E F H G A B L F M R P T J37
P37
J31 D E H G P53 J53 2 1 3 P35 J35 3 1 2 E2 E1 P32 J32 E F B D A C
P31
P38 J38 A B P39 J39 A B
DS2 DS3
E2 E1 BUTT CONNECTOR
REAR LIMIT SWITCH S21 (COVER CLOSED)
FRONT LIMIT SWITCH S25 (COVER CLOSED)
CHASSIS GROUND
SOLENOID COVER CLOSE
SOLENOID COVER OPEN
40A
MTR
HYDRAULIC PUMPING UNIT
TEST CELL LIGHTS
TEST CELL
CONSOLE
K1
4
12 J203-H
DS7
DS8
DS9
DS10
OPERATE
S11
5 A D C D E F G H I
6 A B C D E F G H I J
7 A B C D E F G H I
8 A B C D E F G H I J
9 A B C D E F G H I J
10 A B C D E F G H I J
h f g j k m n p r J205
P205
ELECTRICAL CONTROL
P N O R S T U V W J702
P702
CONSOLE
TEST CELL
P M N R S T U V W J26

J2-5-1-37A


120/240
±10/20 VAC
60-CYCLE
1 ϕ
115 ±5 VAC
400-CYCLE
1ϕ
PHASE
PHASE
GROUND
NEUTRAL
GROUND
NEUTRAL
PHASE
J8 A B C D
J7 D C B A
P9-A 10
P9-B 10
P9-C 10
P9-D 10
SOURCE PANEL
P1 J1
A
B
C
S1 ON OFF
CB1
1 AMP
DS1
AC POWER ON
E1
A1 POWER SUPPLY
CONSOLE
PU VALVE
POSITION CONTROLLER
VALVE OPENING M1
FINE ADJ R2 0-50 Ω
0-2K Ω R1
COARSE ADJ.
METER CALIB. S3
J2
P2
ELECTRICAL CONTROL
MILLIAMETER M1
(250) (50) (500) (-COM)
VOLTMETER M2
(150) (75) (30) (-LOW)
S13A
S13B
RANGE SELECT A-DECK
RANGE SELECT B-DECK
OFF
0.212 Ω 0.5 AMP
S12B
S12A
R4
10
K1
2 Ω 3 WATT R6
C1 0.15 MFD 1K WVDC
R5 0.75 Ω 0.5 WATT
A2 PATCH-BOARD
ELECTRICAL CONTROL
J204 P204
J701 P701
CONSOLE
TEST CELL
J25
J48 J47 J46 J45 J44 J43 J52 J51 J50 J49
6
5
4

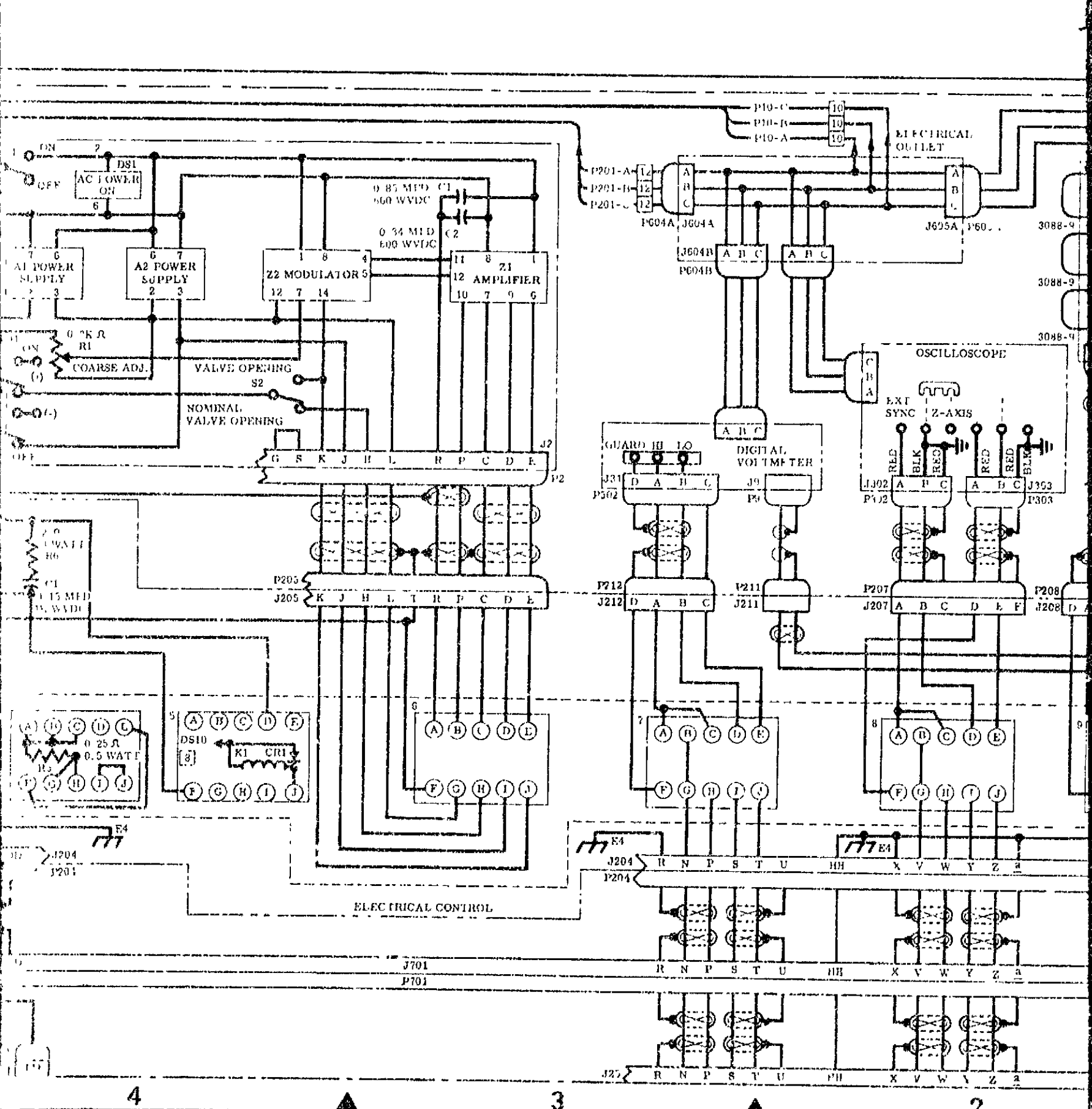


Figure 12-10.

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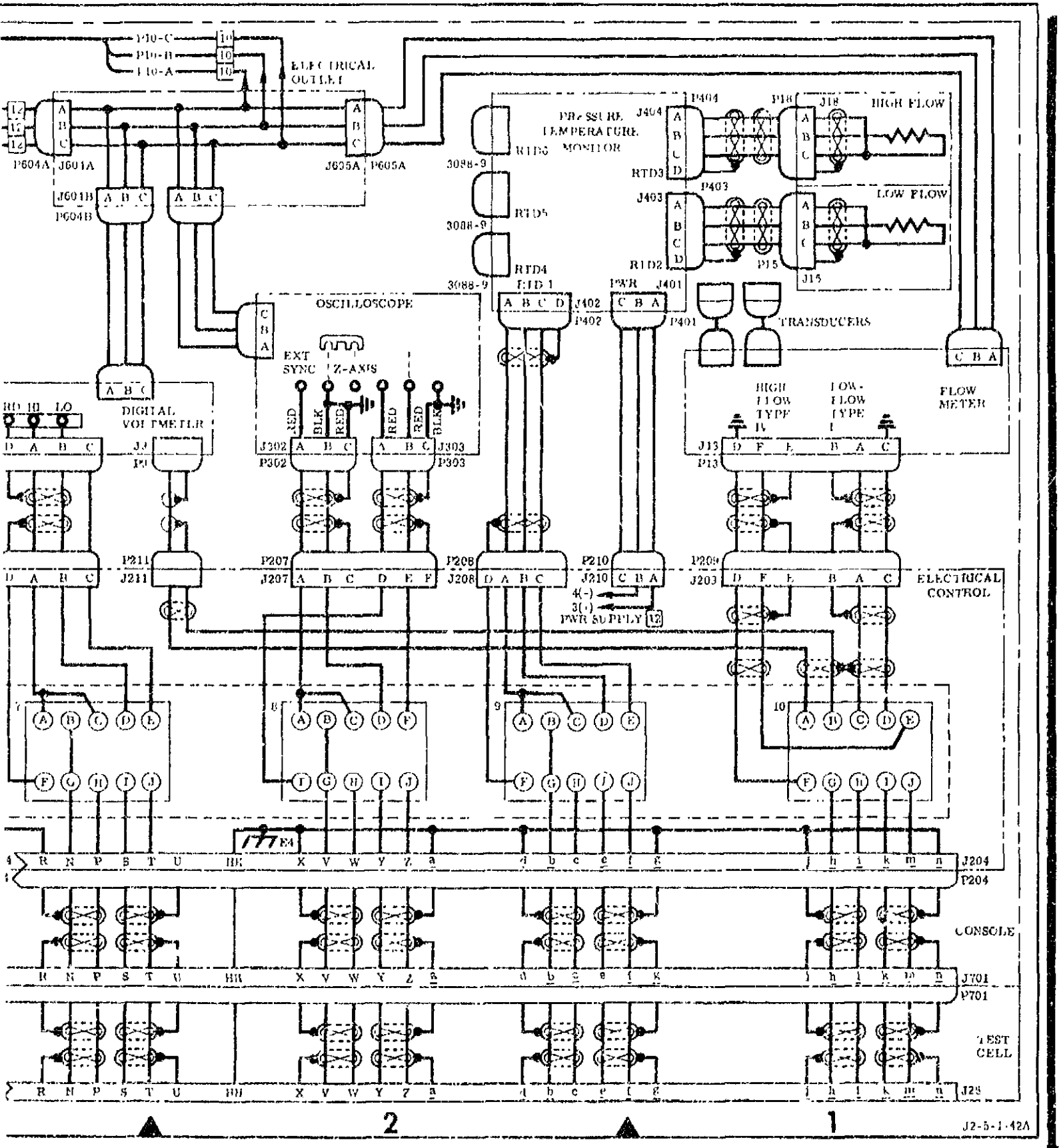

Figure 12-10. Electrical Schematic (Sheet 2 of 2)

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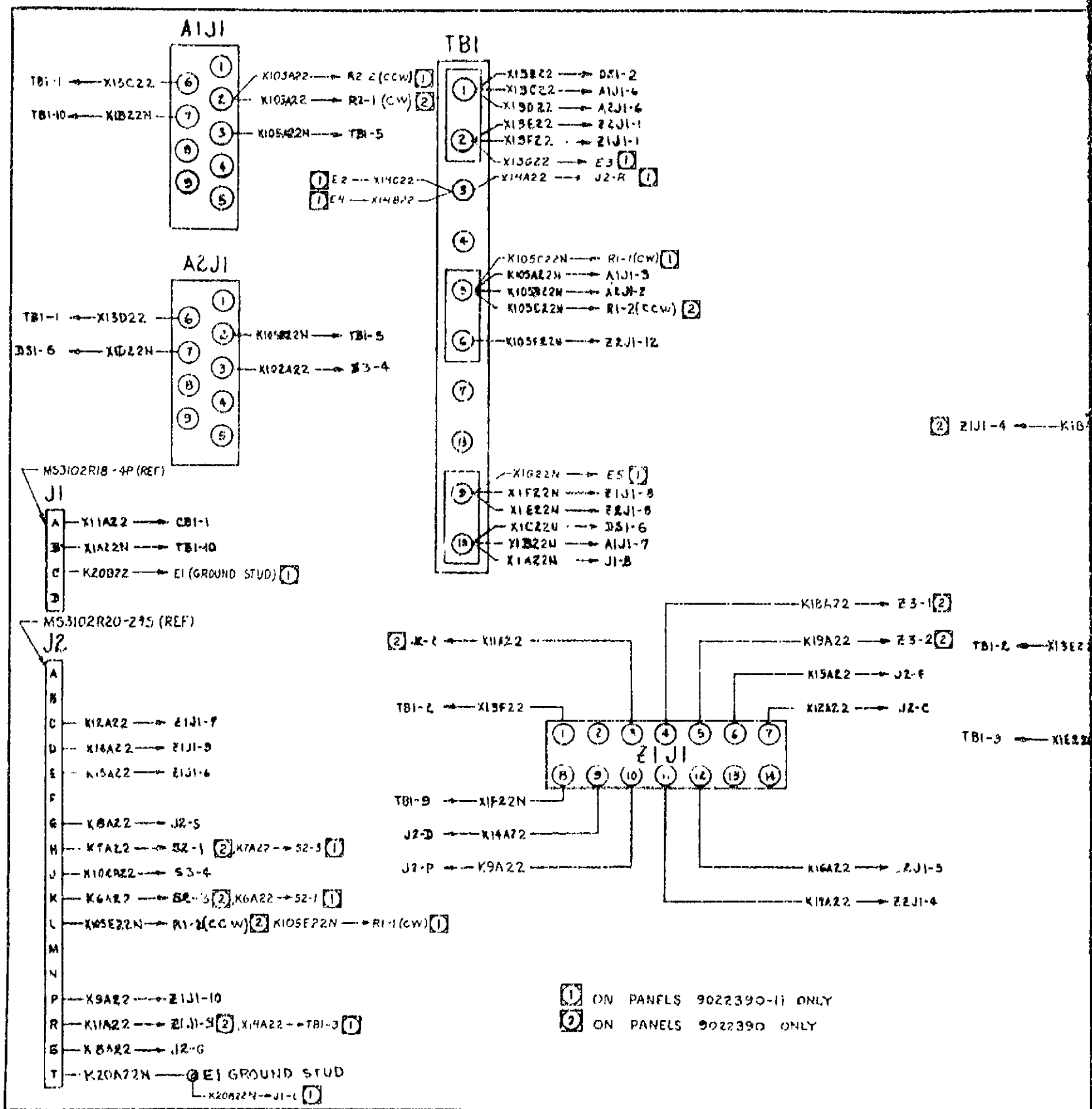

A1J1
TB1-1 — X13C22
TB1-10 — X13B22N
K10SA22 — R2-2(CCW) [1]
K10SA22 — R2-1 (CW) [2]
K10SA22N — TB1-5
A2J1
TB1-1 — X13D22
DS1-6 — X10L22N
K10SB22N — TB1-5
K10ZA22 — S3-4
MS3102R18-4P (REF)
J1
A — X11A22 — CB1-1
B — X1A22N — TB1-40
C — K20B22 — E1 (GROUND STUD) [1]
D
MS3102R20-29S (REF)
J2
C — K12A22 — Z1J1-7
D — K16A22 — Z1J1-9
E — K15A22 — Z1J1-6
G — K8A22 — J2-S
H — K7A22 — S2-1 [2] K7A22 — S2-3 [1]
J — K10KA22 — S3-4
K — K6A22 — S2-3 [2] K6A22 — S2-1 [1]
L — K10SE22N — R1-2(CCW) [2] K10SF22N — R1-1(CW) [1]
P — K9A22 — Z1J1-10
R — K11A22 — Z1J1-5 [2] X14A22 — TB1-3 [1]
S — K8A22 — J2-G
T — K20A22N — E1 GROUND STUD
K20A22N — J1-C [1]
TB1
X13B22 — DS1-2
X13C22 — A1J1-6
X13D22 — A2J1-6
X13E22 — Z2J1-1
X13F22 — Z1J1-1
X13G22 — E3 [1]
[1] E2 — X14C22
[1] E4 — X14B22
X14A22 — J2-R [1]
K10SC22N — R1-1(CW) [1]
K10SA22N — A1J1-5
K10SB22N — A2J1-5
K10SC22N — R1-2(CCW) [2]
K10SF22N — Z2J1-12
X1G22N — E5 [1]
X1F22N — Z1J1-8
X1E22N — Z2J1-8
X1C22N — DS1-6
X1B22N — A1J1-7
X1A22N — J1-B
[2] Z1J1-4 — K16
K18A22 — Z3-1 [2]
[2] K11A22
K19A22 — Z3-2 [2]
TB1-2 — X13E22
K15A22 — J2-F
TB1-2 — X13F22
X12A22 — J2-C
TB1-3 — K1E22
Z1J1
TB1-9 — X1F22N
J2-D — K14A22
J2-P — K9A22
K16A22 — Z2J1-5
K17A22 — Z2J1-4
[1] ON PANELS 9022390-11 ONLY
[2] ON PANELS 9022390 ONLY

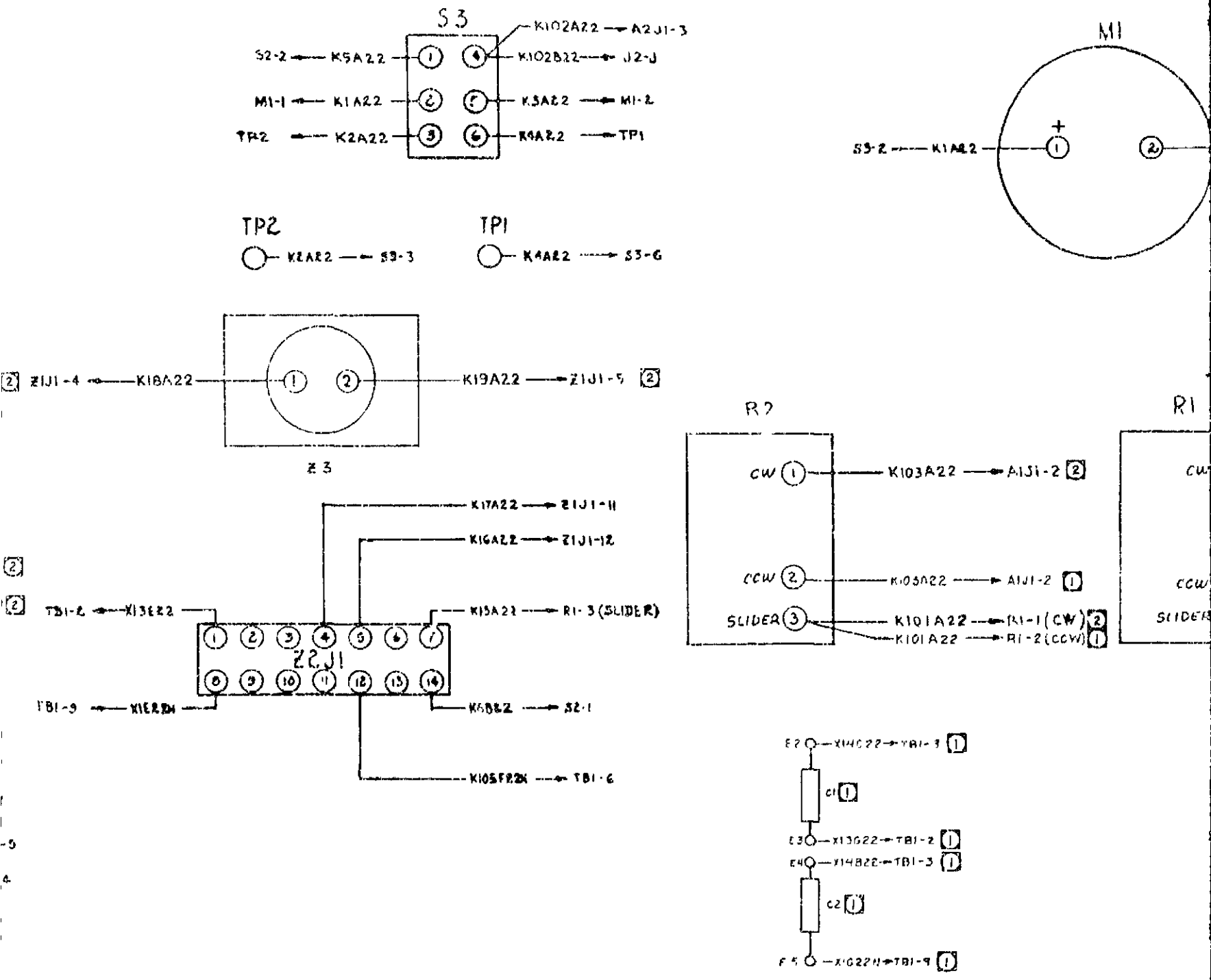


Figure 12-11. Propellar

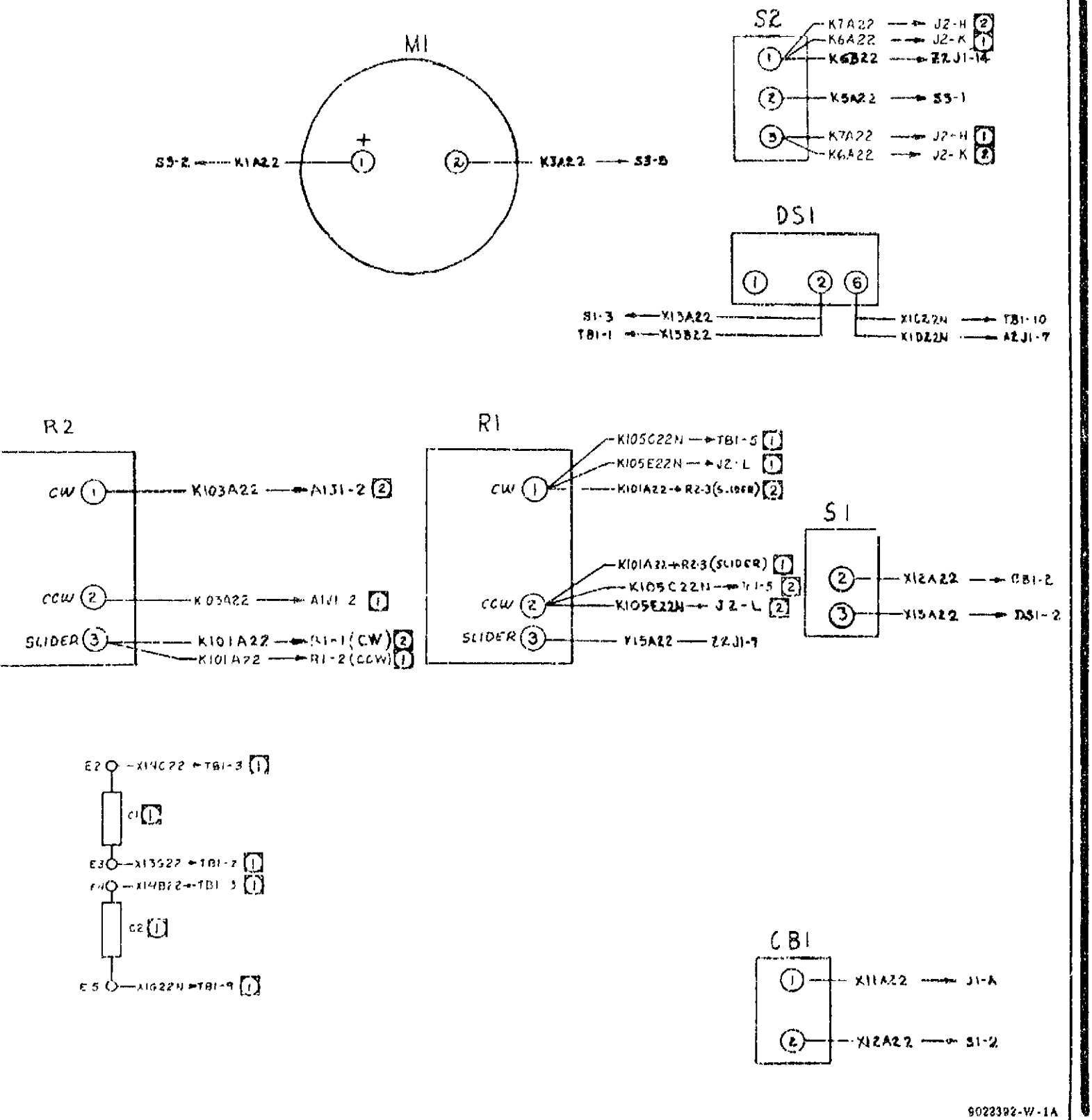
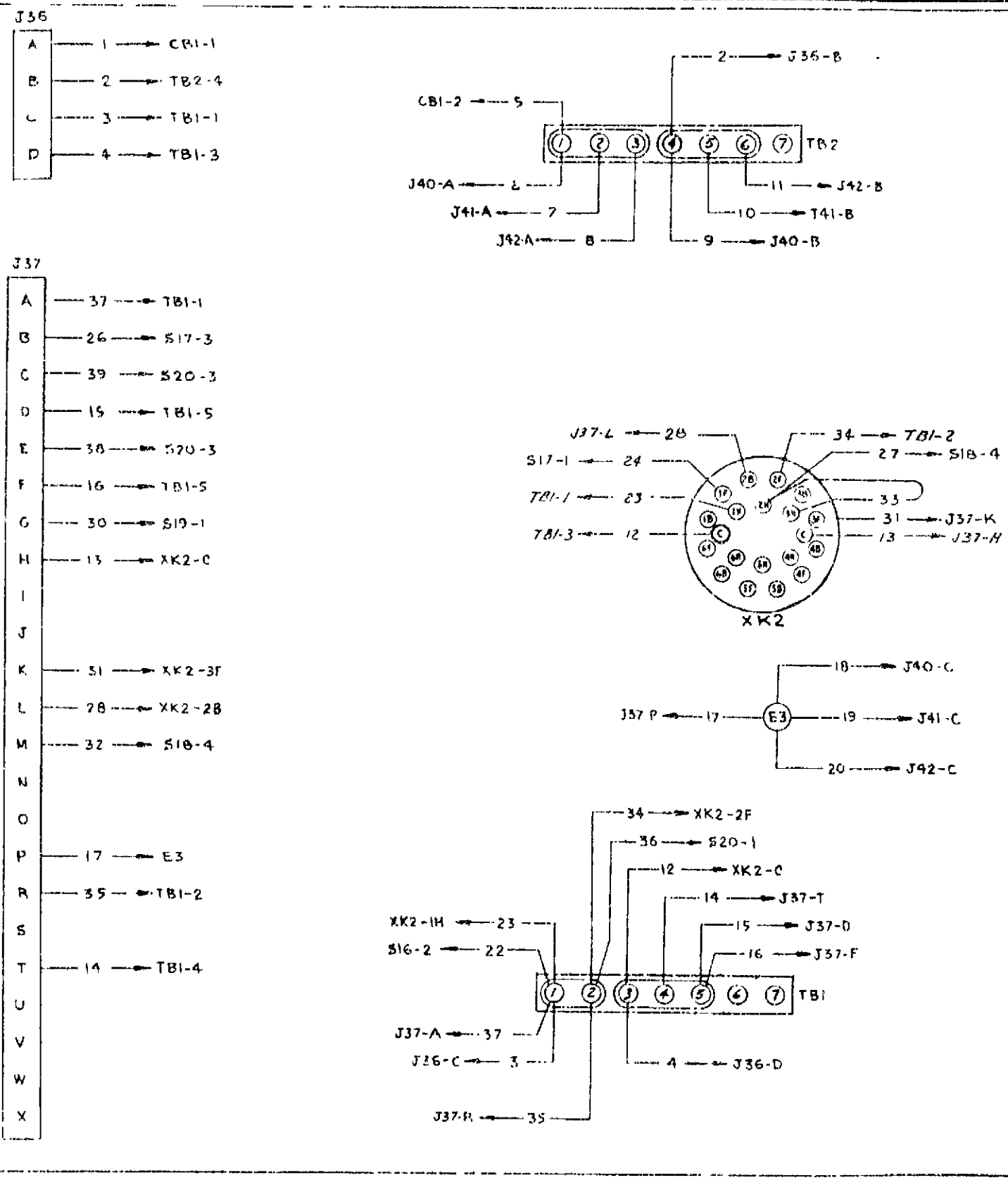


Figure 12-11. Propellant Utilization Valve Position Controller Panel Wiring Diagram


J36
A — 1 — CB1-1
B — 2 — TB2-4
C — 3 — TB1-1
D — 4 — TB1-3
2 — J36-B
CB1-2 — 5
TB2
J40-A — 6
J41-A — 7
J42-A — 8
9 — J40-B
10 — T41-B
11 — J42-B
J37
A — 37 — TB1-1
B — 26 — S17-3
C — 39 — S20-3
D — 15 — TB1-5
E — 38 — S20-3
F — 16 — TB1-5
G — 30 — S19-1
H — 13 — XK2-C
K — 31 — XK2-3F
L — 28 — XK2-2B
M — 32 — S18-4
P — 17 — E3
R — 35 — TB1-2
T — 14 — TB1-4
J37-L — 28
34 — TB1-2
S17-1 — 24
27 — S18-4
TB1-1 — 23
33
31 — J37-K
TB1-3 — 12
13 — J37-H
XK2
J37 P — 17
E3
18 — J40-C
19 — J41-C
20 — J42-C
34 — XK2-2F
36 — S20-1
12 — XK2-C
14 — J37-T
XK2-1H — 23
15 — J37-D
S16-2 — 22
16 — J37-F
TB1
J37-A — 37
J36-C — 3
4 — J36-D
J37-R — 35

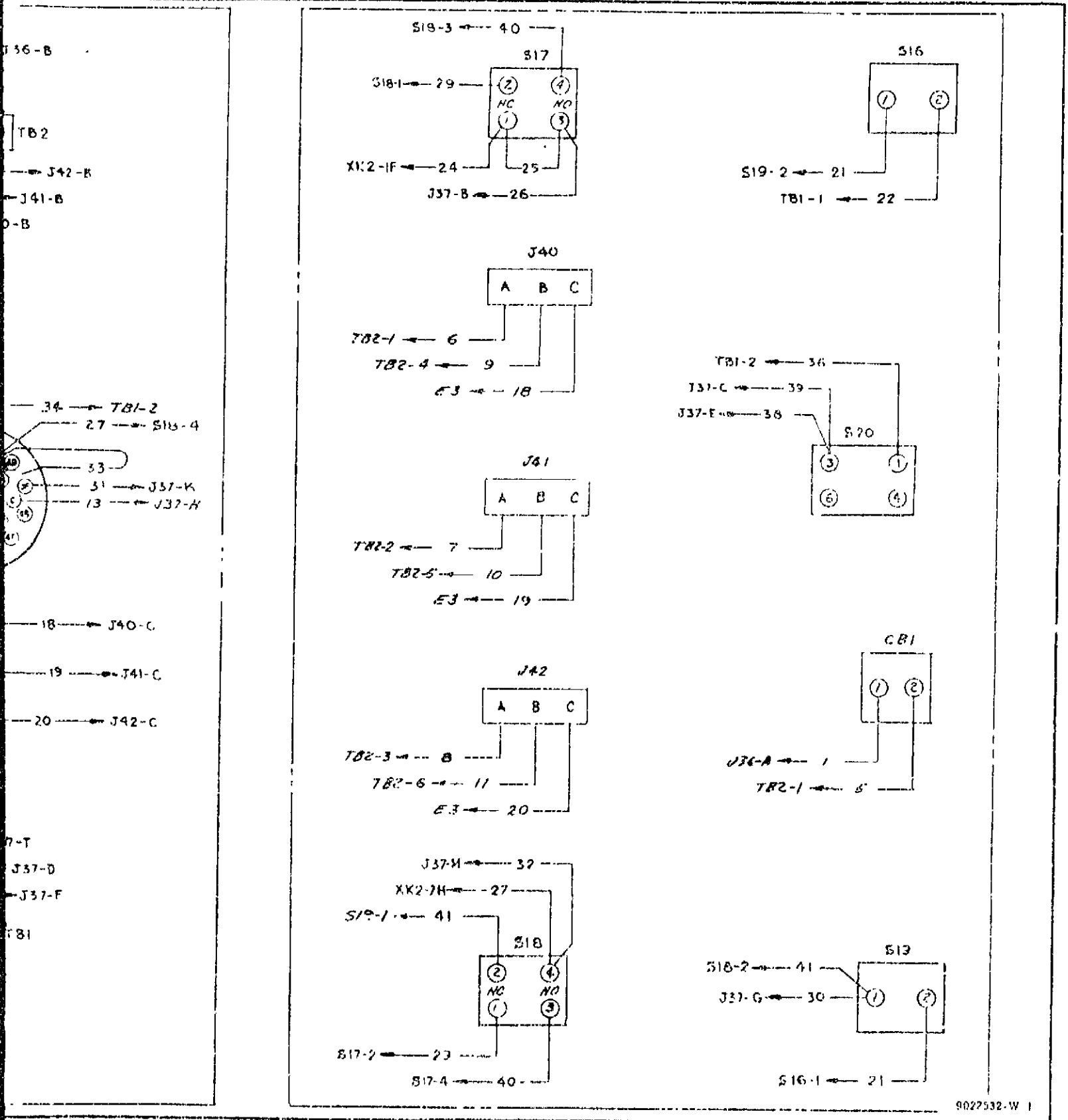


Figure 12-12. Test Cell Utility Panel Wiring Diagram

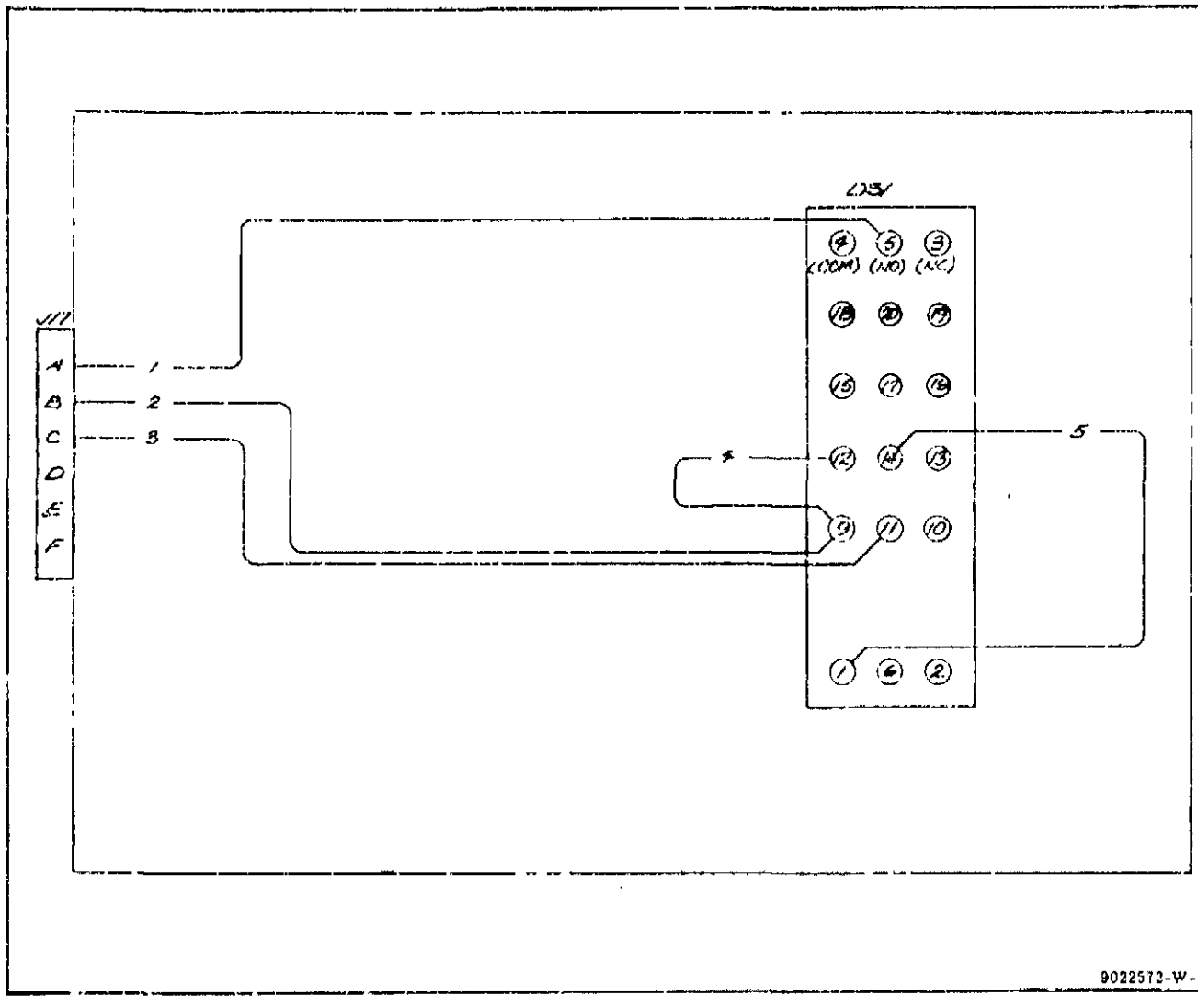
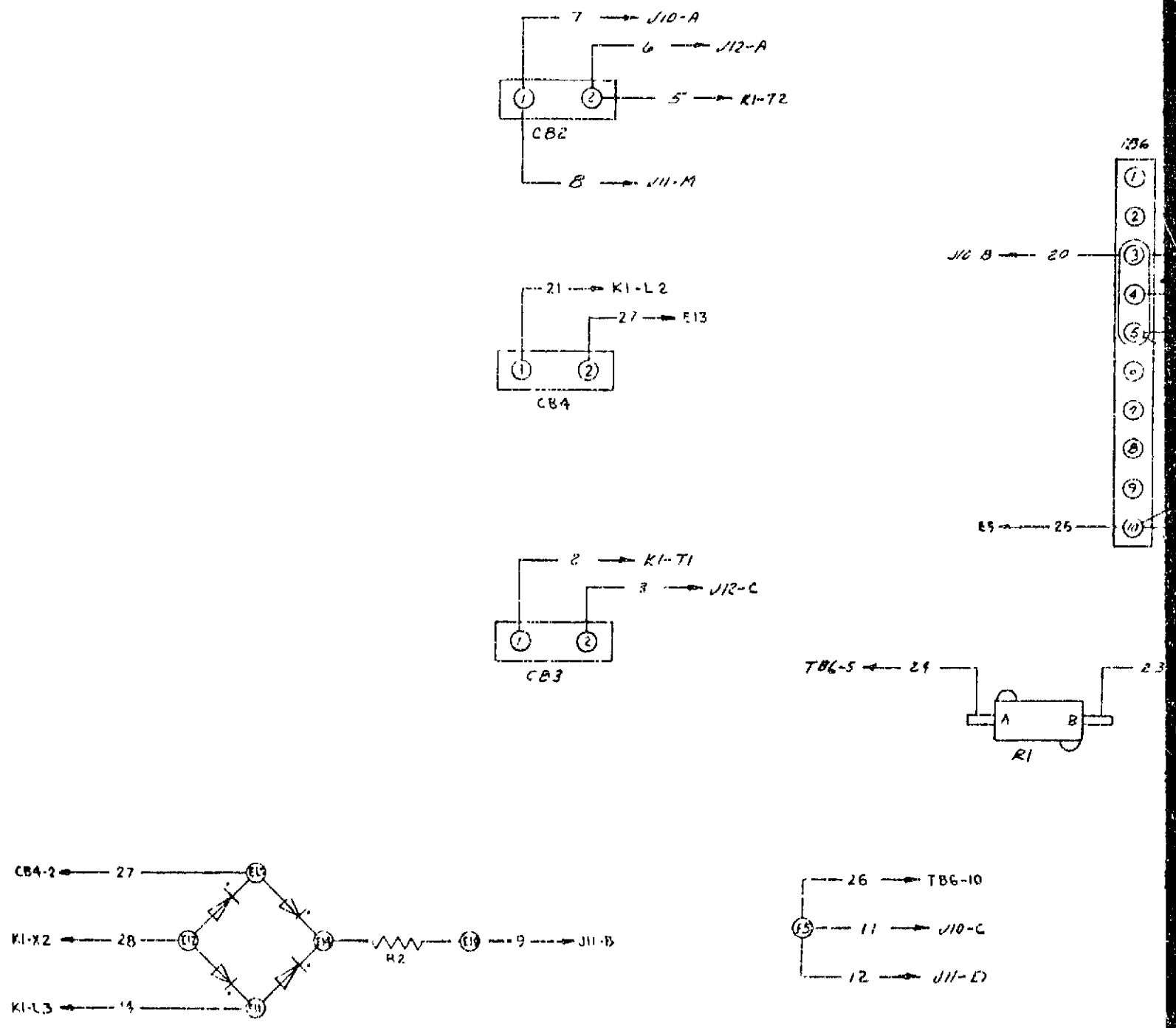


Figure 12-13. Liquid Nitrogen Tank Pressure Panel Wiring Diagram


7 → J10-A
6 → J12-A
5 → K1-T2
CB2
8 → J11-M
J1C B → 20
21 → K1-L2
27 → E13
CB4
2 → K1-T1
3 → J12-C
CB3
TB6-5 → 24
23
A
B
R1
CB4-2 → 27
K1-X2 → 28
K1-L3 → 14
R2
9 → J11-B
26 → TB6-10
11 → J10-C
12 → J11-D

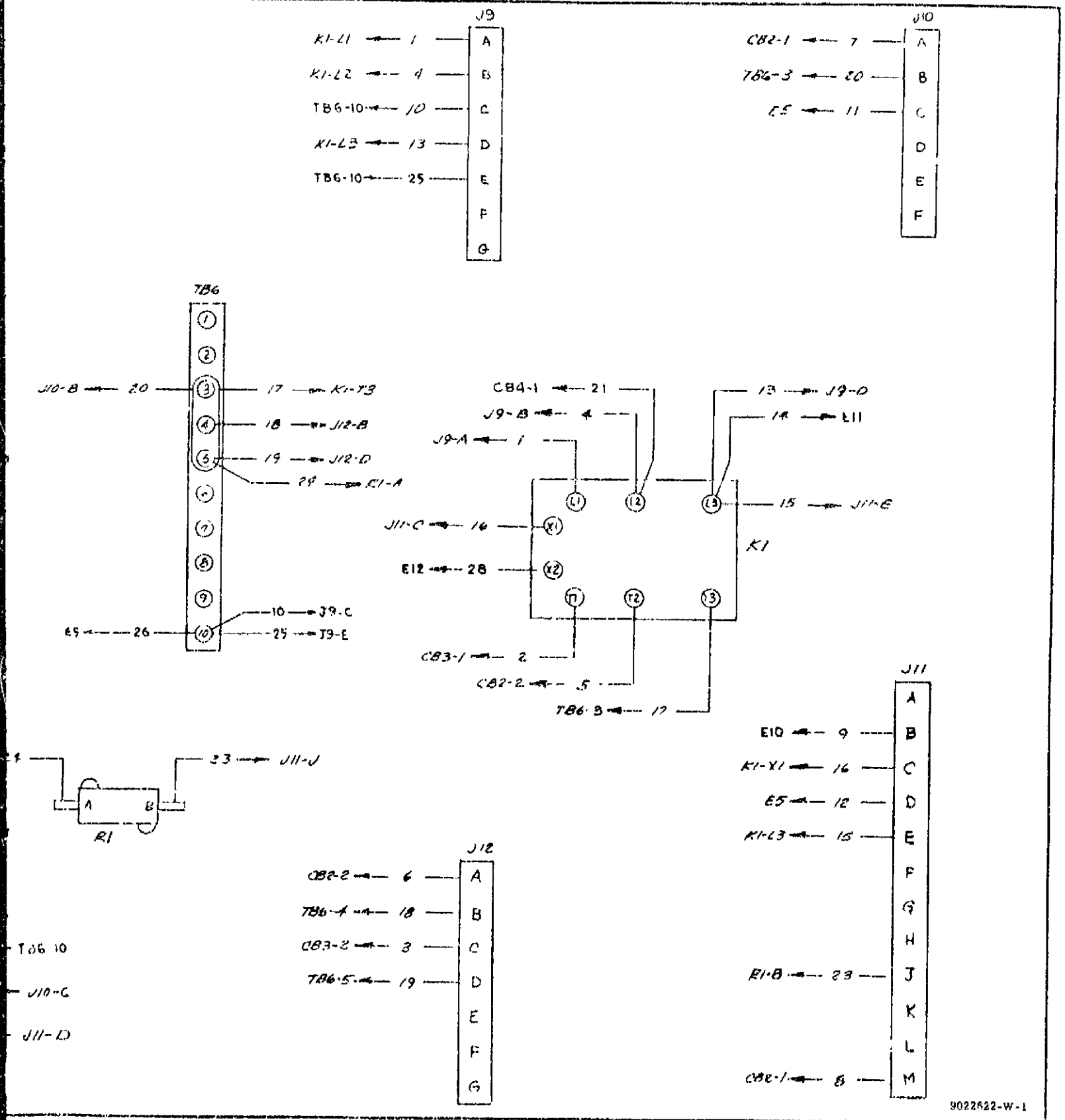


Figure 12-14. Power Distribution Panel Wiring Diagram

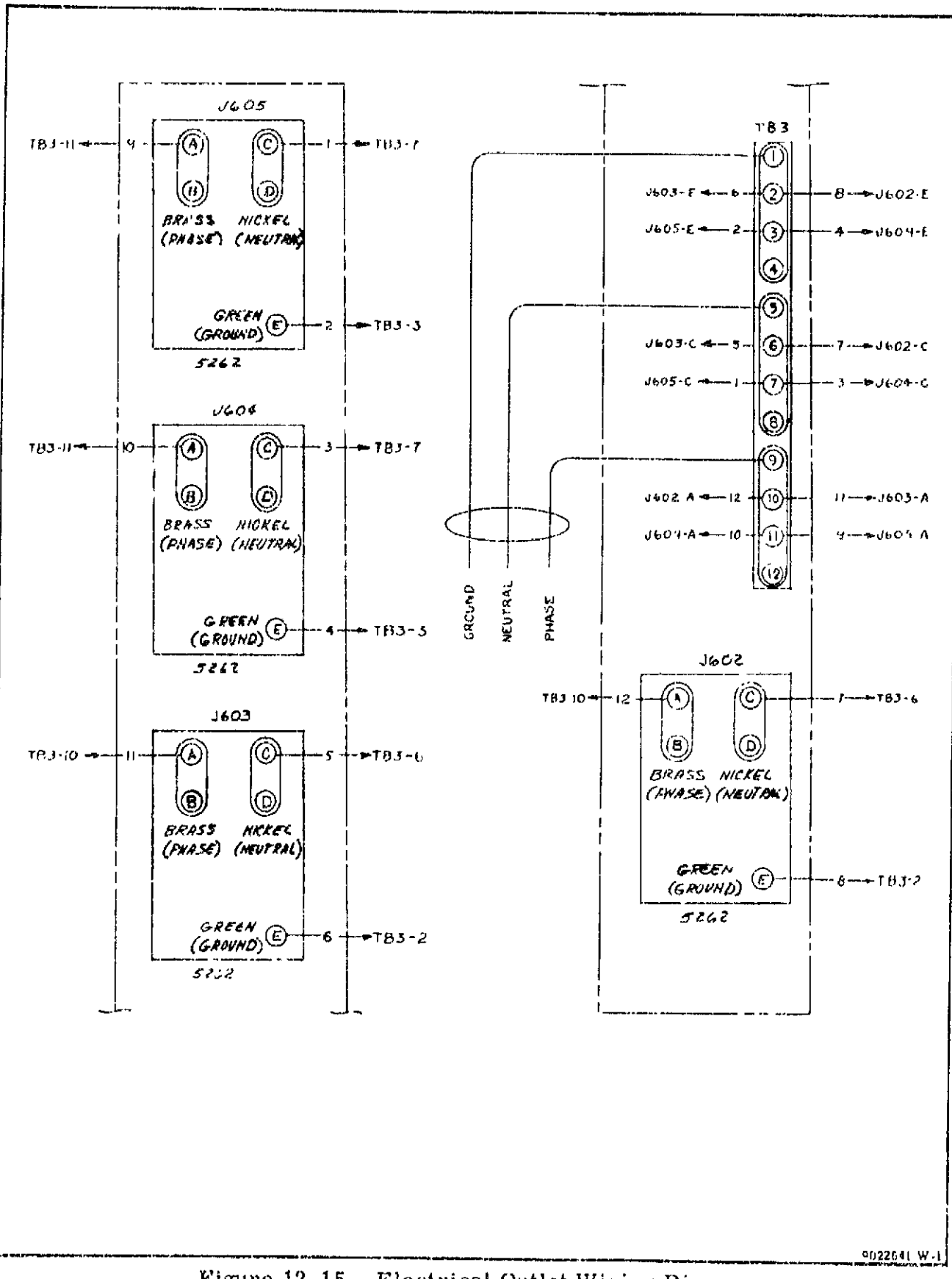


Figure 12-15. Electrical Outlet Wiring Diagram

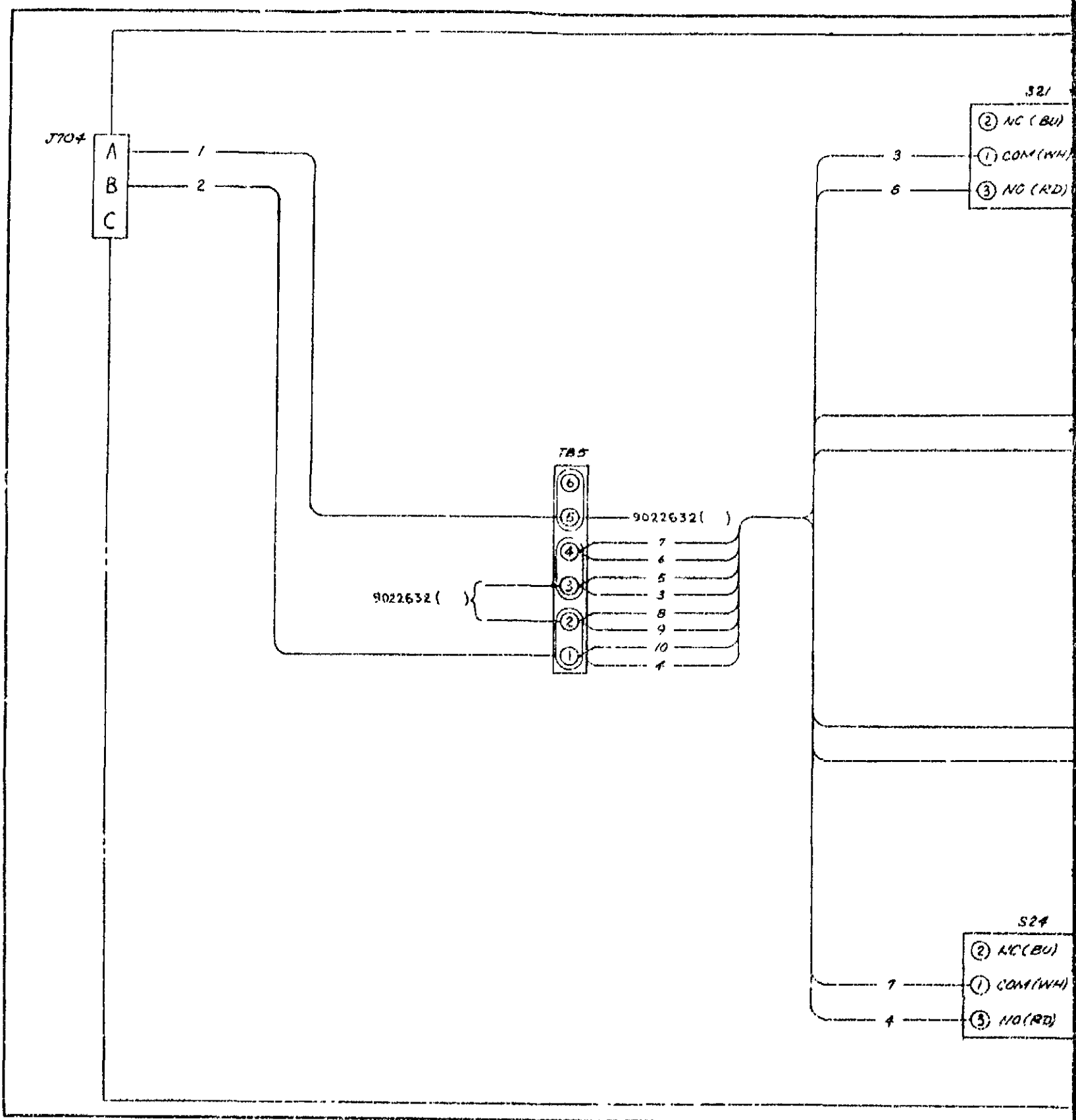


Figure 12-16. Pr

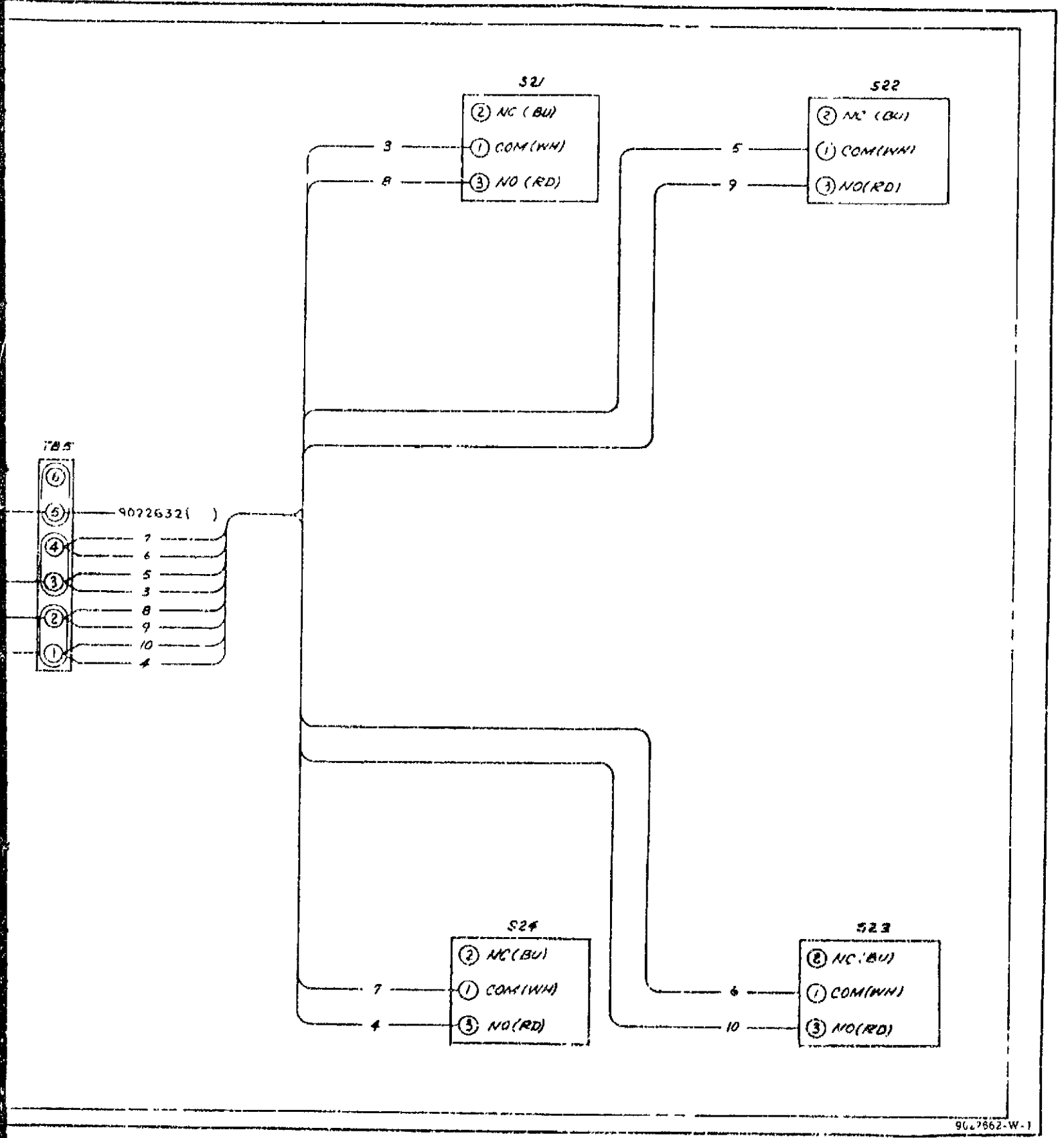


Figure 12-16. Pressure Switch Wiring Diagram

From Component and Terminal	Wire No.	To Component and Terminal
CONNECTORS		
J201-A	193	TB3-47
-B	192	J203-B
-C	191	J203-C
J202-A	196	DS1-C1
-B	197	DS1-C2
-C	301	E4
-D	190	TB1-50
-E	188	J205-A
-F	201	S2-B2
-G	299	TB3-12
-H	300	TB1-9
J203-A	194	TB3-47
-B	192	J201-B
-C	191	J201-C
-E	199	R3-C(R)
-F	200	R3-A(L)
-G	209	TB3-12
-H	302	TB3-14
-J(j)	349	J203-K
-K(j)	349	J203-J
-L(j)	350	J203-M
-M(j)	350	J203-L
-T	207	TB1-49
J204-A	113	A2-1G
-B	114	A2-1H
-C	82	TB1-40
-D	116	A2-1J
-E	115	A2-1I

From Component and Terminal	Wire No.	To Component and Terminal
CONNECTORS		
J204-F	318	TB3-19
-G	100	A2-2G
-H	101	A2-2H
-J	319	TB3-21
-K	103	A2-2J
-L	102	A2-2I
-M	320	TB3-20
-N	37	A2-7G
-P	38	A2-7H
-R	322	TB3-23
-S	39	A2-7I
-T	40	A2-7J
-U	321	TB3-22
-V	27	A2-8G
-W	28	A2-8H
-X	323	TB3-23
-Y	29	A2-8I
-Z	30	A2-8J
-a	324	TB3-24
-b	17	A2-9G
-c	18	A2-9H
-d	325	TB3-24
-e	19	A2-9I
-f	20	A2-9J
-g	326	TB3-25

(j) Added on panels 9022610-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 1 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
CONNECTORS		
J204-h	7	A2-10G
-i	8	A2-10H
-j	327	TB3-25
-k	9	A2-10I
-m	10	A2-10J
-n	328	TB3-26
-r	329	TB3-26
-s	92	TB1-10
-t	91	TB1-11
-u	330	TB3-27
-v	90	TB1-12
-w	89	TB1-13
-x	331	TB3-27
-y	88	TB1-14
-z	87	TB1-15
-AA	332	TB3-28
-BB	86	TB1-16
-CC	85	TB1-17
-DD	333	TB3-28
-EE	84	TB1-18
-FF	83	TB1-19
-GG	334	TB3-29
-HH	93	E4
J205-A	188	J202E
-B	189	TB1-50

From Component and Terminal	Wire No.	To Component and Terminal
CONNECTORS		
J205-C	43	A2-6C
-D	44	A2-6D
-E	45	A2-6E
-H	46	A2-6H
-J	49	A2-6I
-K	50	A2-6J
-L	47	A2-6G
-P	42	A2-6B
-R	41	A2-6A
-S	179	A1-1I
-T	46	A2-6F
-U	177	A1-1H
-V	176	A1-2I
-W	175	A1-2J
-X	174	A1-2H
-Z	173	A1-3I
-a	172	A1-3J
-b	171	A1-3H
-c	170	A1-4I
-d	169	A1-4J
-e	168	A1-4H
-f	167	A1-5I
-g	166	A1-5J
-h	165	A1-5H
-j	164	A1-6I

Figure 12-17. Electrical Control Panel Wire List (Sheet 2 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
CONNECTORS		
J205-k	163	A1-6J
-m	162	A1-7I
-n	161	A1-7J
-p	160	A1-8I
-r	159	A1-8J
-s	178	A1-1J
J207-A	21	A2-8C
-B	22	A2-8D
-D	24	A2-8F
-E	23	A2-8E
J208-A	11	A2-9C
-B	12	A2-9D
-C	13	A2-9E
-D	14	A2-9F
J209-A	1-RD	A2-10C
-B	3	(a)
-C	1-BU	A2-10D
-D	2-BU	A2-10F
-E	4	(b)
-F	2-RD	A2-10E
J210-A	316	PS2-3
-B	317	PS2-4
J211 (pin)	312RD	A2-10A
J211 (lug)	312BU	A2-10B
(a)	346	(a)
J212-A	31	A2-7C
-B	32	A2-7D
-C	33	A2-7E
-D	34	A2-7F
GROUND STUDS		
E4	93	J204-HH
	301	J202-C
	342	TB3-30
LIGHTS		
DS1-1	203	TB3-42
-3	204	TB3-41
-5	195	TB1-50
-5	315	PS2-2
-C1	196	J202-A
-C2	197	J202-B
-C3	202	TB3-50
DS3-1	284	DS3-2
-1	292	DS4-1
-2	236	S2-A2
-2	284	DS3-1
-3	244	DS3-B2
-4	283	A1-1D
-5	228	TB3-11

(a) Connects shield ferrule of wire number 312 to wire number 1.
(b) Wire number 1 shield ferrule.

Figure 12-17. Electrical Control Panel Wire List (Sheet 3 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
LIGHTS		
DS3-B1	237	TB1-47
-E2	244	DS3-3
-C1	280	A1-1A
-C2	282	A1-1C
-C3	281	A1-1B
DS4-1	285	DS4-2
-1	292	DS3-1
-2	293	DS5-2
-3	245	DS4-B2
-4	279	A1-2D
-5	229	TB3-10
-B1	238	TB1-46
-B2	245	DS4-3
-C1	276	A1-2A
-C2	278	A1-2C
-C3	277	A1-2B
DS5-1	286	DS5-2
-1	294	DS6-1
-2	286	DS5-1
-2	293	DS4-2
-3	246	DS5-B2
-4	275	A1-3D
-5	230	TB3-9
-B1	239	TB1-45
-B2	246	DS5-3

From Component and Terminal	Wire No.	To Component and Terminal
LIGHTS		
DS5-C1	272	A1-3A
-C2	274	A1-3C
-C3	273	A1-3B
DS6-1	287	DS6-2
-1	294	DS5-1
-1	295	DS10-2
-2	287	DS6-1
-3	247	DS6-B2
-4	271	A1-4D
-5	231	TB3-8
-B1	240	TB1-44
-B2	247	DS6-3
-C1	268	A1-4A
-C2	270	A1-4C
-C3	269	A1-4B
DS7-1	288	DS7-2
-1	296	DS8-1
-2	288	DS7-1
-3	248	DS7-B2
-4	267	A1-5D
-5	232	TB3-7
-B1	241	TB3-1
-B2	248	DS7-3
-C1	264	A1-5A
-C2	266	A1-5C

Figure 12-17. Electrical Control Panel Wire List (Sheet 4 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
LIGHTS		
DS7-C3	265	A1-5B
DS8-1	289	DS8-2
-1	296	DS7-1
-1	297	DS9-1
-2	289	DS8-1
-3	249	DS8-B2
-4	263	A1-6D
-5	233	TB3-6
-B1	242	TB3-2
-B2	249	DS8-3
-C1	260	A1-6A
-C2	262	A1-6C
-C3	261	A1-6B
DS9-1	290	DS9-2
-1	297	DS8-1
-1	298	DS10-1
-2	290	DS9-1
-3	250	DS9-B2
-4	259	A1-7D
-5	234	TB3-5
-B1	243	TB3-3
-B2	250	DS9-3
-C1	256	A1-7A
-C2	258	A1-7C
-C3	257	A1-7B
LIGHTS		
DS10-1	291	DS10-2
-1	298	DS9-1
-2	291	DS10-1
-2	295	DS6-1
-3	251	DS10-B2
-4	255	A1-8D
-5	220	TB3-4
-B1	218	TB1-41
-B2	251	DS10-3
-C1	252	A1-8A
-C2	254	A1-8C
-C3	253	A1-8B
METERS		
M1-A(500)	110	A2-1D
-A(500)(i)	137	S12A-3
-A(500)(j)	347	S12A-3
-B(250)	109	A2-1C
-B(250)	138	S12A-4
-C(50)	108	A2-1B
-C(50)	139	S12A-5
-D(COM)	111	A2-1E
-D(COM)	112	A2-1F
-D(+COM)(i)	142	S12B-10
-D(+COM)(j)	348	S12B-10
M2-A(150)	97	A2-2D
-A(150)	104	S13A-3
-B(75)	96	A2-2C

(i) Deleted on panels 9022610-11.
(j) Added on panels 9022610-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 5 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
METERS		
M2-B(75)	105	S13A-4
-C(30)	95	A2-2B
-C(30)	106	S13A-5
-D(-LOW)	98	S13B-3
-D(-LOW)	99	A2-2F
PATCH-BOARDS		
A1-1A	280	DS3-C1
-1B	281	DS3-C3
-1C	180	A1-1E
-1C	282	DS3-C2
-1D	283	DS3-4
-1E	180	A1-1C
-1F	144	A1-2F
-1G	151	A1-2G
-1H	177	J205-U
-1I	179	J205-S
-1J	178	J205-s
A1-2A	276	DS4-C1
-2B	276	DS4-C3
-2C	181	A1-2E
-2C	278	DS4-C2
-2D	279	DS4-4
-2E	181	A1-2C
-2F	144	A1-1F
PATCH-BOARDS		
A1-2F	145	A1-3F
-2G	151	A1-1G
-2G	152	A1-3G
-2H	174	J205-X
-2I	176	J205-V
-2J	175	J205-W
A1-3A	272	DS5-C1
-3B	273	DS5-C3
-3C	182	A1-3E
-3C	274	DS5-C2
-3D	275	DS5-4
-3E	182	A1-3C
-3F	145	A1-2F
-3F	146	A1-4F
-3G	152	A1-2G
-3G	153	A1-4G
-3H	171	J205-b
-3I	173	J205-Z
-3J	172	J205-a
A1-4A	268	DS6-C1
-4B	269	DS6-C3
-4C	183	A1-4E
-4C	270	DS6-C2

Figure 12-17. Electrical Control Panel Wire List (Sheet 6 of 15)

From Component and Terminal	Wire No.	To Component and Terminal	From Component and Terminal	Wire No.	To Component and Terminal
PATCH-BOARDS			PATCH-BOARDS		
A1-4D	271	DS6-4	A1-6C	262	DS8-C2
-4E	183	A1-4C	-6D	263	DS8-4
-4F	146	A1-3F	-6E	185	A1-6C
-4F	147	A1-5F	-6F	148	A1-6F
-4G	153	A1-3G	-6F	149	A1-7F
-4G	154	A1-5G	-6G	155	A1-5G
-4H	168	J205-e	-6G	156	A1-7G
-4I	170	J205-c	-6I	164	J205-j
-4J	169	J205-d	-6J	163	J205-k
A1-5A	264	DS7-C1	A1-7A	256	DS9-C1
-5B	265	DS7-C3	-7B	257	DS9-C3
-5C	184	A1-5E	-7C	186	A1-7E
-5C	266	DS7-C2	-7C	258	DS9-C2
-5D	267	DS7-4	-7D	259	DS9-4
-5E	184	A1-5C	-7E	186	A1-7C
-5F	147	A1-4F	-7F	149	A1-6F
-5F	148	A1-6F	-7F	150	A1-8F
-5G	154	A1-4G	-7G	156	A1-6G
-5G	155	A1-6G	-7G	157	A1-8G
-5H	165	J205-h	-7I	162	J205-m
-5I	167	J205-f	-7J	161	J205-n
-5J	166	J205-g	A1-8A	252	DS10-C1
A1-6A	260	DS8-C1	-8B	253	DS10-C3
-6B	261	DS8-C3	-8C	187	A1-8E
-6C	185	A1-6E	-8C	254	DS10-C2

Figure 12-17. Electrical Control Panel Wire List (Sheet 7 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
PATCH-BOARDS		
A1-8D	255	DS10-4
-8E	187	A1-8C
-8F	150	A1-7F
-8G	157	A1-7G
-8I	160	J205-p
-8J	159	J205-r
A1-9A	121	S11-2
-9B	122	S11-3
-9C	123	S11-1
-9D	124	A1-9E
-9D	219	TB3-4
-9E	124	A1-9D
-9E	125	A1-9F
-9F	125	A1-9E
-9G	127	A1-9H
-9H	127	A1-9G
-9H	128	A1-9I
-9I	128	A1-9H
-9I	129	A1-9J
-9J	129	A1-9I
A1-10A	117	S11-5
-10B	118	S11-6
-10C	119	S11-4
-10D	120	TB3-14
-10D	136	A1-10E

From Component and Terminal	Wire No.	To Component and Terminal
PATCH-BOARDS		
A1-10E	135	A1-10F
-10E	136	A1-10D
-10F	135	A1-10E
-10G	133	A1-10H
-10H	132	A1-10I
-10H	133	A1-10G
-10I	131	A1-10J
-10I	132	A1-10H
-10J	131	A1-10I
A2-1A	107	S12A-C
-1B	108	M1-C(50)
-1C	109	M1-B(250)
-1D	110	M1-A(500)
-1E	111	M1-D(+COM)
-1F	112	M1-D(+COM)
-1G	113	J204-A
-1H	114	J204-B
-1I	115	J204-E
-1J	116	J204-D
A2-2A	94	S13A-C
-2B	95	M2-C(30)
-2C	96	M2-B(75)
-2D	97	M2-A(150)
-2E	307	S13B-C
-2F	99	M2-D(-LOW)

Figure 12-17. Electrical Control Panel Wire List (Sheet 8 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
PATCH-BOARDS		
A2-2G	100	J204-G
-2H	101	J204-H
-2J	102	J204-L
-2J	103	J204-K
A2-3A	77	TB1-14
-3B	76	TB1-15
-3C	75	TB1-16
-3D	74	TB1-17
-3E	73	TB1-18
-3F	72	TB1-19
-3G	78	TB1-13
-3H	79	TB1-12
-3I	80	TB1-11
-3J	81	TB1-10
A2-4A	67	TB1-24
-4B	66	TB1-25
-4C	65	TB1-26
-4D	64	TB1-27
-4E	63	TB1-28
-4F	62	TB1-29
-4G	68	TB1-23
-4H	69	TB1-22
-4I	70	TB1-21
-4J	71	TB1-20
PATCH-BOARDS		
A2-5A	57	TB1-34
-5B	56	TB1-35
-5C	55	TB1-36
-5D	54	TB1-37
-5E	53	TB1-38
-5F	52	TB1-39
-5G	58	TB1-33
-5H	59	TB1-32
-5I	60	TB1-31
-5J	61	TB1-30
A2-6A	41	J205-R
-6B	42	J205-P
-6C	43	J205-C
-6D	44	J205-D
-6E	45	J205-E
-6F	46	J205-T
-6F	51	TB1-40
-6G	47	J205-L
-6H	48	J205-H
-6I	49	J205-J
-6J	50	J205-K
A2-7A	35	A2-7C
-7B	36	A2-7G
-7C	31	J212-A

Figure 12-17. Electrical Control Panel Wire List (Sheet 9 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
PATCH-BOARDS		
A2-7C	35	A2-7A
-7D	32	J212-B
-7E	33	J212-C
-7F	34	J212-D
-7G	36	A2-7B
-7G	37	J204-N
-7H	38	J204-P
-7I	39	J204-S
-7J	40	J204-T
A2-8A	25	A2-8C
-8B	26	A2-8G
-8C	21	J207-A
-8C	25	A2-8A
-8D	22	J207-B
-8E	23	J207-E
-8F	24	J207-D
-8G	26	A2-8B
-8G	27	J204-V
-8H	28	J204-W
-8I	29	J204-Y
-8J	30	J204-Z
A2-9A	15	A-20C
-9B	16	A2-9G
PATCH-BOARDS		
A2-9C	11	J208-A
-9C	15	A2-9A
-9D	12	J208-B
-9E	13	J208-C
-9F	14	J208-D
-9G	16	A2-9B
-9G	17	J204-b
-9H	18	J204-c
-9I	19	J204-e
-9J	20	J204-f
A2-10A	312RD	J211(PIN)
-10B	312BU	J211(LUG)
-10C	1RD	J209-A
-10D	1BU	J209-C
-10E	2RD	J209-F
-10F	2BU	J209-D
-10G	7	J204-h
-10H	8	J204-i
-10I	9	J204-k
-10J	10	J204-m
(b)	3	J209-B
(c)	4	J209-E
(a)	346	(a)

(a) Connects shield ferrule of wire number 312 to wire number 1.
(b) Wire number 1 shield ferrule.
(c) Wire number 2 shield ferrule.

Figure 12-17. Electrical Control Panel Wire List (Sheet 10 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
POWER SUPPLY		
PS2-1	314	TB3-49
-2	315	DS1-5
-3	316	J210-A
-4	317	J210-B
BRIDGE RECTIFIER		
Red	--	TB3-37
Yellow(d)	--	TB3-38
Yellow(d)	--	TB3-40
(Unmarked)	--	TB3-39
RELAYS		
K1-7(j)	357	TB2-8A
-12(j)	356	TB2-1A
-X1(j)	351	TB1-30
-X1(j)	352	TB2-10A
-X2(j)	353	TB2-10B
-X2(j)	354	TB3-5
RESISTORS		
R1 (Connected across TB3-41 and TB3-49)		
R2 (Connected across TB3-42 and TB3-50)		
R3-A(L)	200	J203-F
-A(L)	206	R3-B(C)
-B(C)	206	R3-A(L)
-C(R)	199	J203-E

From Component and Terminal	Wire No.	To Component and Terminal
RESISTORS		
R4 (Connected across S12B-10 and S12B-c)		
R5 (Connected across TB1-23 and TB1-24)		
SWITCHES		
S2-A1	205	S2-B1
-A1	235	TB1-48
-A2	236	DS3-2
-B1	205	S2-A1
-B2	201	J202-F
S11-1	123	A1-9C
-2	121	A1-9A
-3	122	A1-9B
-4	119	A1-10C
-5	117	A1-10A
-6	118	A1-10B
S12A-2	140	S12A-3
-2	141	S12B-2
-3(i)	137	M1-A(500)
-3(j)	347	M1-A(500)
-3	140	S12A-2
-4	138	M1-B(250)
-5	139	M1-C(50)
-C	107	A2-1A

(d) Relationship of leads and TB3 terminals is optional.
(i) Deleted on panels 9022610-11.
(j) Added on panels 9022610-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 11 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
SWITCHES		
S12B-2	141	S12A-2
-10(i)	142	M1-D(+COM)
-10(j)	348	M1-D(+COM)
-10	--	R4
-C	--	R4
S13A-3	104	M2-A(150)
-3	306	TB3-37
-4	105	M2-B(75)
-5	106	M2-C(30)
S13A-C	94	A2-2A
-C	305	TB3-38
S13B-2	308	TB3-40
-3	98	M2-D(-LOW)
-3	309	S13B-4
-4	309	S13B-3
-4	310	S13B-5
-5	310	S13B-4
-5	311	TB3-39
-C	307	A2-2E
TERMINAL BOARDS		
TB1-9	143	TB1-49
-9	300	J202-H
-10	81	A2-3J
-10	92	J204-s
-11	80	A2-3I
-11	91	J204-t
-12	79	A2-3H
-12	90	J204-v
-13	78	A2-3G
-13	89	J204-w
-14	77	A2-3A

From Component and Terminal	Wire No.	To Component and Terminal
TERMINAL BOARDS		
TB1-14	88	J204-y
-15	76	A2-3B
-15	87	J204-z
-16	75	A2-3C
-16	86	J204-BB
-17	74	A2-3D
-17	85	J204-CC
-18	73	A2-3E
-18	84	J204-EE
-19	72	A2-3F
-19	83	J204-FF
-20	71	A2-4J
-20	126	TB1-21
-21	70	A2-4I
-21	126	TB1-20
-22	69	A2-4H
-22	130	TB1-23
-23	68	A2-4G
-23	130	TB1-22
-23	--	R5
-24	67	A2-4A
-24	134	TB1-25
-24	--	R5
-25	66	A2-4B
-25	134	TB1-24
-25	158	TB1-26
-26	65	A2-4C
-26	158	TB1-25
-27	64	A2-4D

(i) Deleted on panels 9022610-11.
(j) Added on panels 9022610-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 12 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
TERMINAL BOARDS		
TB1-28	63	A2-4E
-28	304	TB1-29
-29	62	A2-4F
-29	304	TB1-28
-30	61	A2-5J
-30(j)	351	K1-X1
-31	60	A2-5I
-32	59	A2-5H
-33	58	A2-5G
-34	57	A2-5A
-35	56	A2-5B
-36	55	A2-5C
-37	54	A2-5D
-37(j)	355	TB2-1A
-38	53	A2-5E
-39	52	A2-5F
-39(j)	358	TB2-8A
-40	51	A2-6F
-40	82	J204-C
-41	213	TB1-43
-41	218	DS10-B1
-42	198	TB1-43
-42	214	TB1-44
-42	345	TB3-2
-43	198	TB1-42
-43	212	TB1-45
-43	213	TB1-41
-44	214	TB1-42
-44	215	TB1-46
TERMINAL BOARDS		
TB1-44	215	TB1-46
-44	240	DS6-B1
-45	211	TB1-47
-45	212	TB1-43
-45	239	DS5-B1
-46	215	TB1-44
-46	216	TB1-48
-46	238	DS4-B1
-47	208	TB1-49
-47	211	TB1-45
-47	237	DS3-B1
-48	216	TB1-46
-48	235	S2-A1
-49	143	TB1-9
-49	207	J203-T
-49	208	TB1-47
-50	189	J205-B
-50	190	J202-D
-50	195	DS1-5
TB2-1A(j)	355	TB1-37
-1A(j)	356	K1-12
-1B(j)	359	TB2-3A
-3A(j)	359	TB2-1B
-8A(j)	357	K1-7
-3A(j)	358	TB1-39
-10A(j)	352	K1-X1
-10B(j)	353	K1-X2
TB3-1	241	DS7-B1
-1	343	TB3-3
-1	344	TB3-2
-2	242	DS8-B1
-2	344	TB3-1

(j) Added on panels 9022610-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 13 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
TERMINAL BOARDS		
TB3-2	345	TB1-42
-3	243	DS9-B1
-3	343	TB3-1
-4	319	A1-9D
-4	320	DS10-5
-4	321	TB3-6
-5	227	TB3-7
-5	234	DS9-5
-5 (j)	354	K1-X2
-6	221	TB3-4
-6	222	TB3-8
-6	233	DS8-5
-7	226	TB3-9
-7	227	TB3-5
-7	232	DS7-5
-8	222	TB3-6
-8	223	TB3-10
-8	231	DS6-5
-9	225	TB3-11
-9	226	TB3-7
-9	230	DS5-5
-10	217	TB3-11
-10	223	TB3-8
-10	224	TB3-10
-10	229	DS4-5
-11	217	TB3-10

From Component and Terminal	Wire No.	To Component and Terminal
TERMINAL BOARDS		
TB3-11	225	TB3-9
-11	228	DS3-5
-12	209	J203-G
-12	224	TB3-10
-12	299	J202-G
-14	120	A1-10D
-14	302	J203-H
-19	318	J204-F
-20	320	J204-M
-21	319	J204-J
-22	321	J204-U
-23	322	J204-R
-23	323	J204-X
-23	335	TB3-25
-24	324	J204-a
-24	325	J204-d
-24	341	TB3-26
-25	326	J204-g
-25	327	J204-j
-25	336	TB3-27
-25	355	TB3-23
-26	328	J204-n
-26	329	J204-r
-26	340	TB3-28
-26	341	TB3-24

(j) Added on panels 9022010-11.

Figure 12-17. Electrical Control Panel Wire List (Sheet 14 of 15)

From Component and Terminal	Wire No.	To Component and Terminal
TERMINAL BOARDS		
TB3-27	330	J204-u
-27	331	J204-x
-27	336	TB3-25
-27	337	TB3-29
-28	332	J204-AA
-28	333	J204-DD
-28	339	TB3-30
-28	340	TB3-26
-29	334	J204-GG
-29	337	TB3-27
-29	338	TB3-30
-30	338	TB3-29
-30	339	TB3-28
-30	342	E4
-37	306	S13A-3
-37	--	(e)
-38	305	S13A-C
TERMINAL BOARDS		
TB3-38	--	(f) (d)
-39	311	S13B-5
-39	--	(g)
-40	308	S13B-2
-40	--	(h) (d)
-41	204	DS1-3
-41	--	R1
-42	203	DS1-1
-42	--	R2
-47	193	J201-A
-47	194	J203-A
-47	210	TB3-49
-49	210	TB3-47
-49	314	PS2-1
-49	--	R1
-50	202	DS1-C3
-50	--	R2

(d) Relationship of leads and TB3 terminals is optional.

(e) Bridge rectifier, red lead.

(f) Bridge rectifier, yellow lead.

(g) Bridge rectifier, unmarked lead.

(h) Bridge rectifier, yellow lead.

Figure 12-17. Electrical Control Panel Wire List (Sheet 15 of 15)

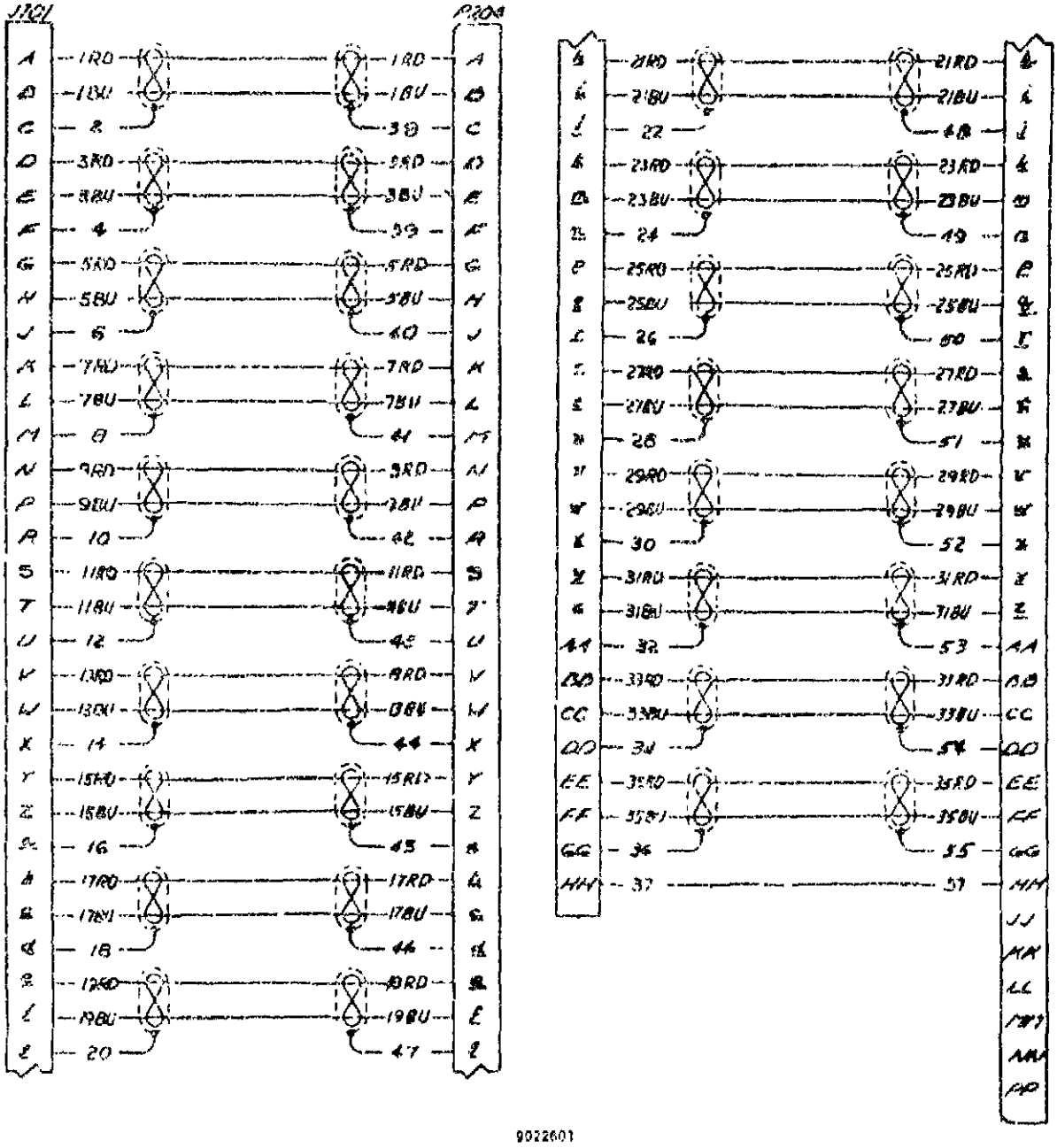


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 1 of 8)

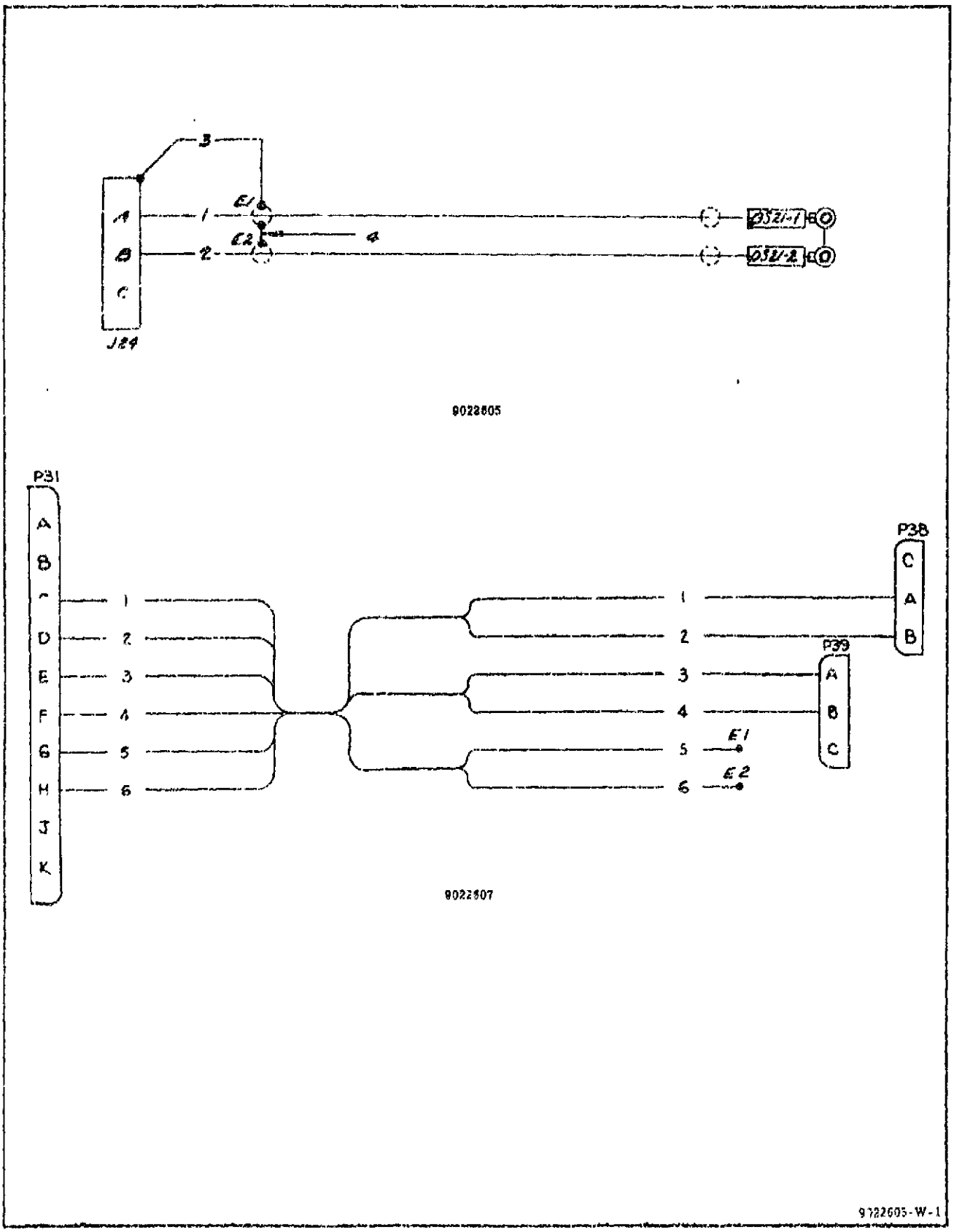


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 2 of 8)

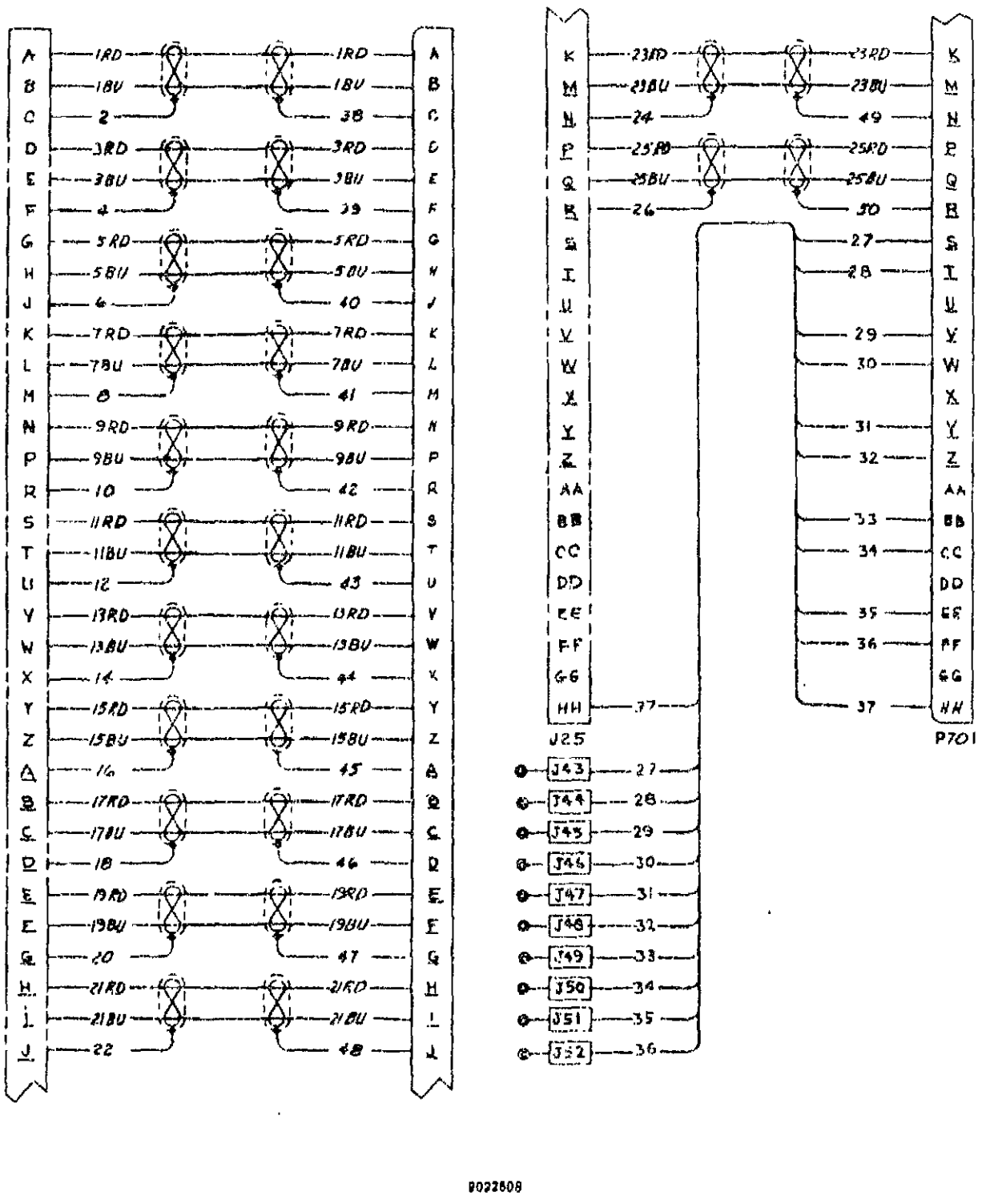


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 3 of 8)

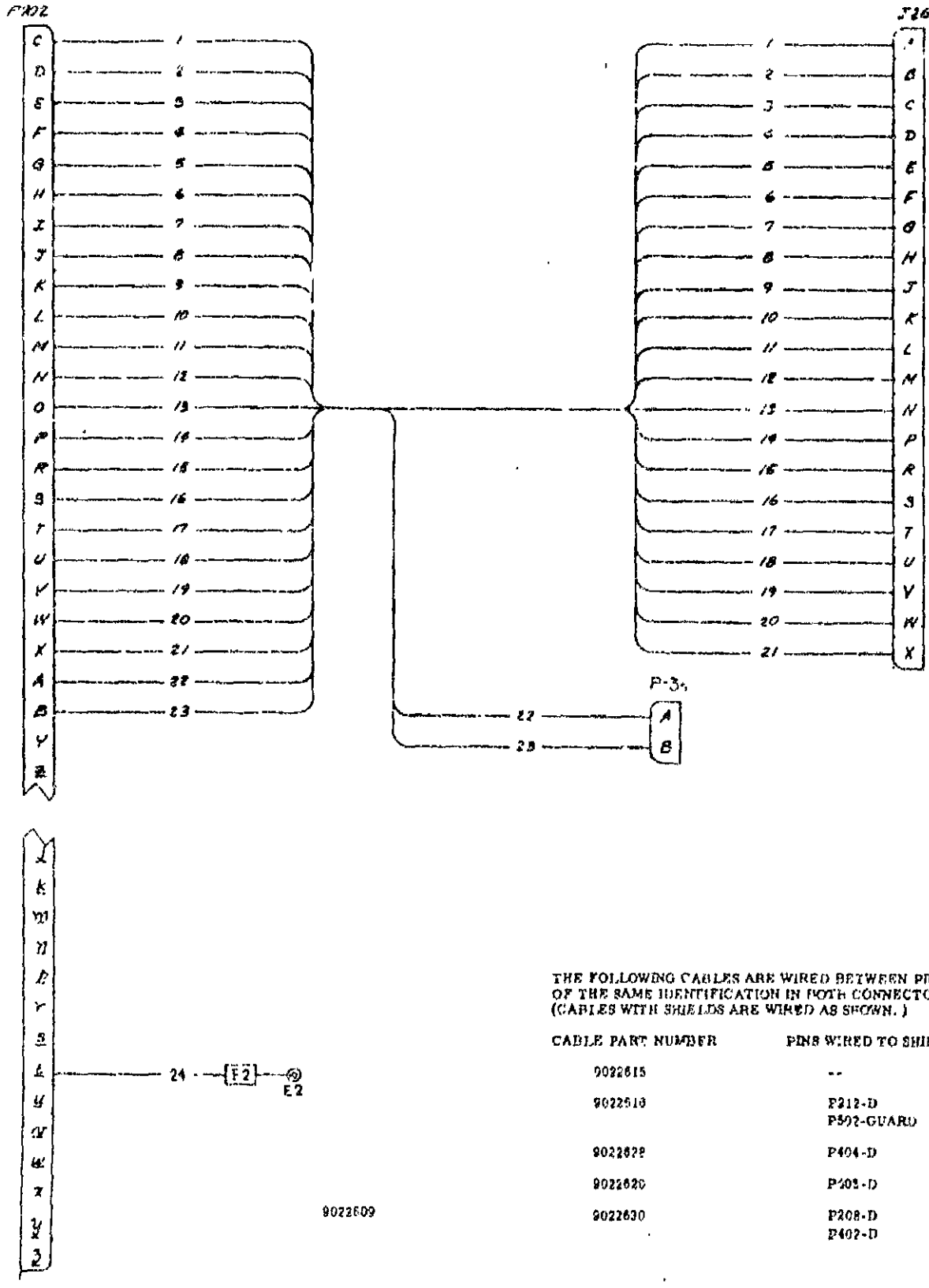


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 1 of 8)

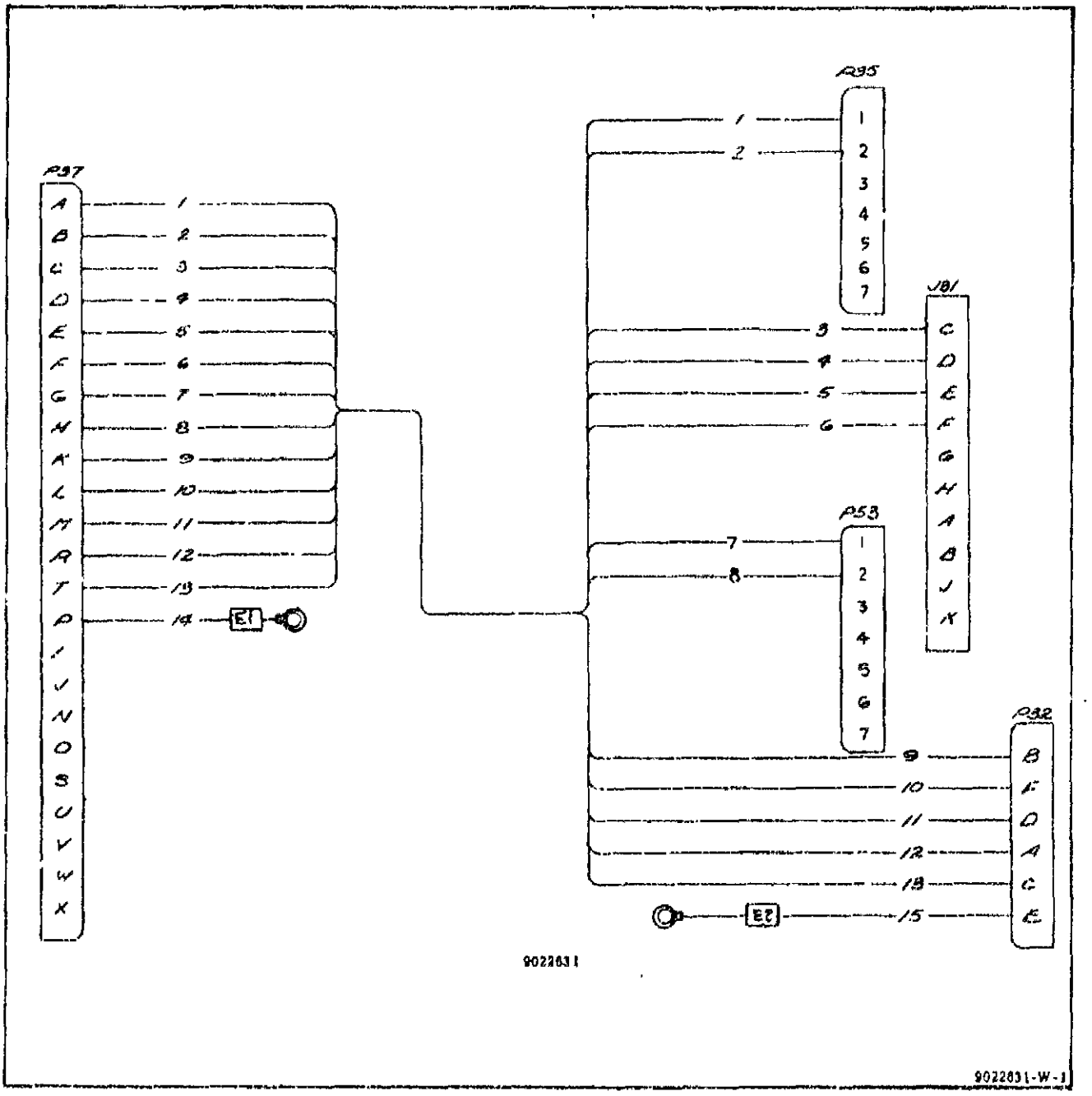
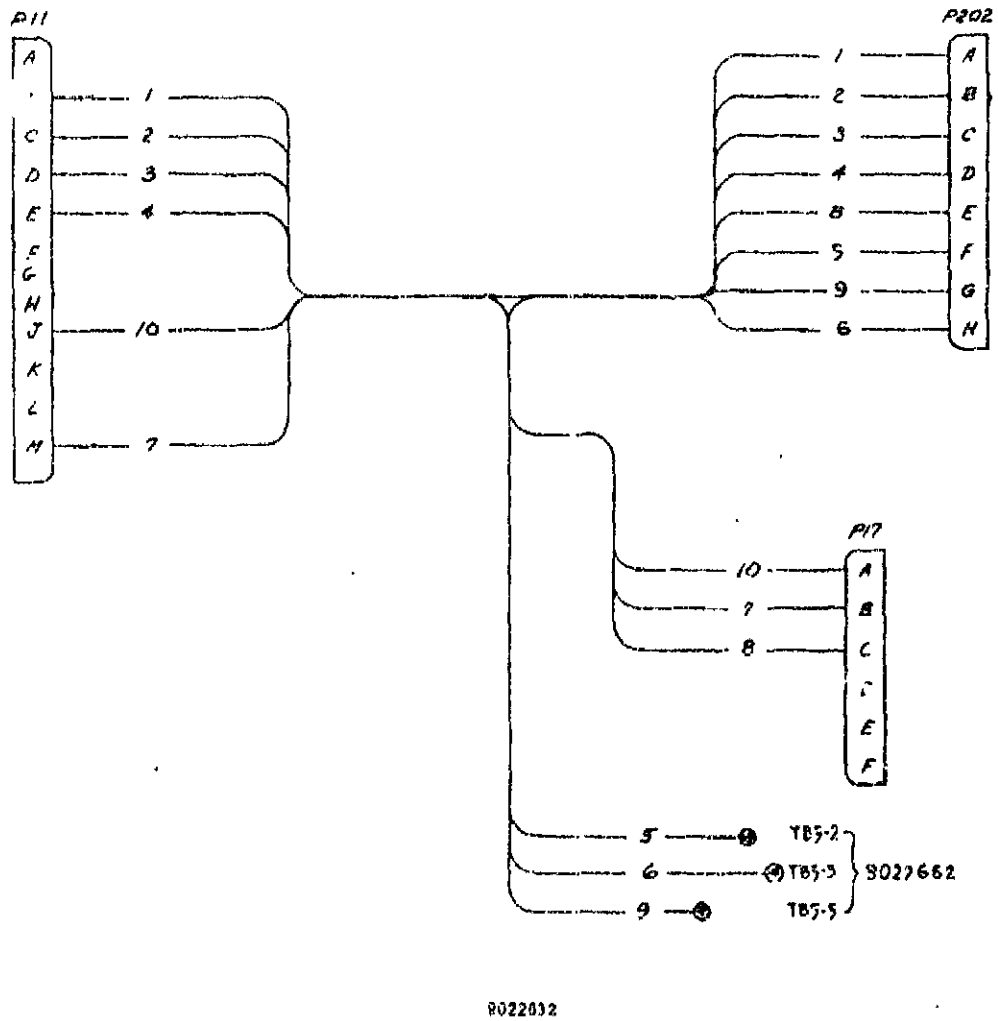


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 5 of 8)



THE FOLLOWING CABLES ARE WIRED BETWEEN PINS OF THE SAME IDENTIFICATION IN BOTH CONNECTORS: (CABLES WITH SHIELD ARE WIRED AS SHOWN.)

CABLE PART NUMBERS	REMARKS
9022633	--
9022634	--
9022635	P12 PINS E, F, AND G ARE NOT WIRED.
9022636	P13-B IS WIRED TO SHIELD 1BU-1RD. P13-R IS WIRED TO SHIELD 2BU-2RD. P209-B IS WIRED TO SHIELD 1BU-1RD. P209-E IS WIRED TO SHIELD 2BU-2RD.

9022632-W-1

Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 6 of 8)

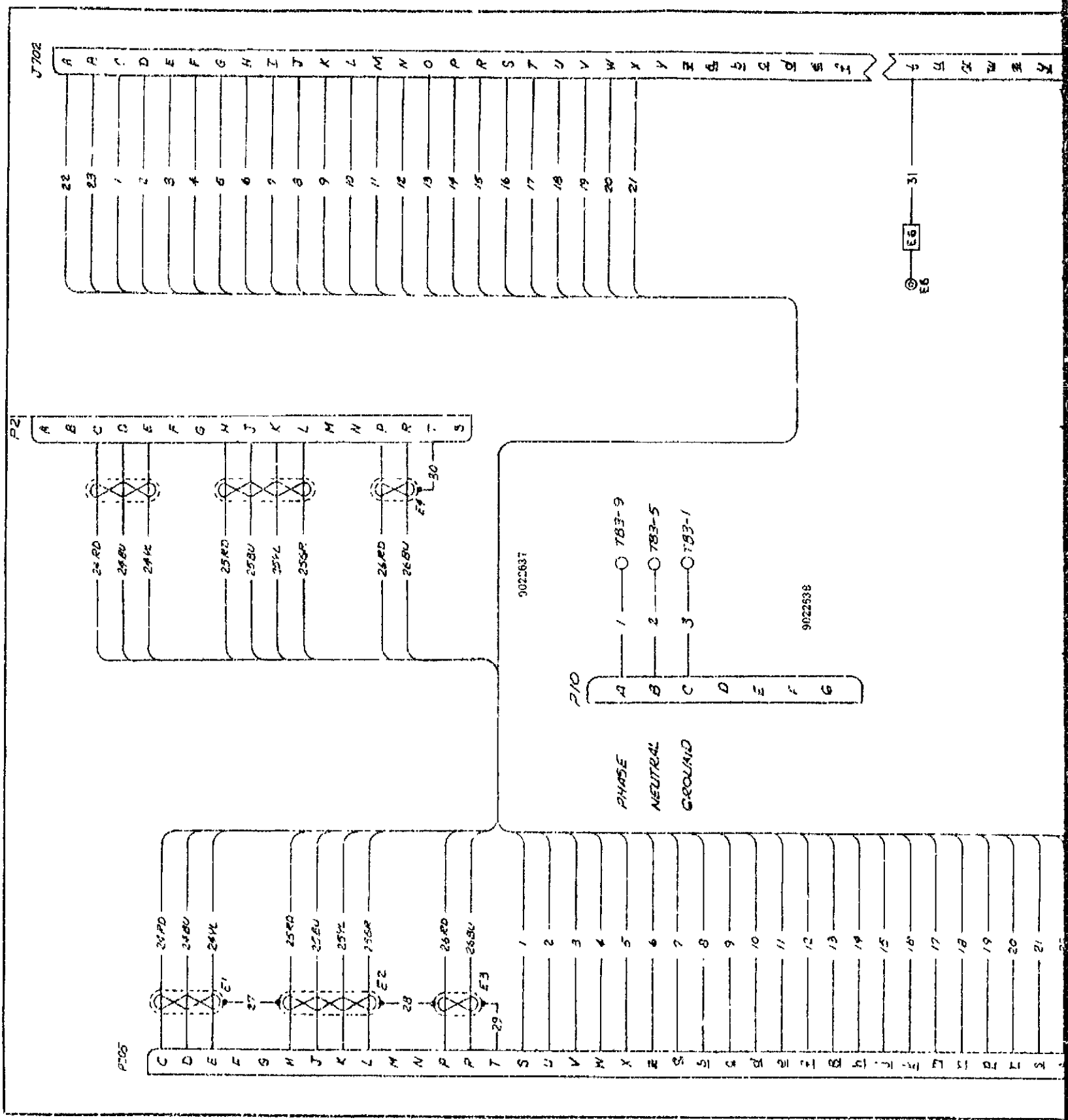


Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 7 of 8)

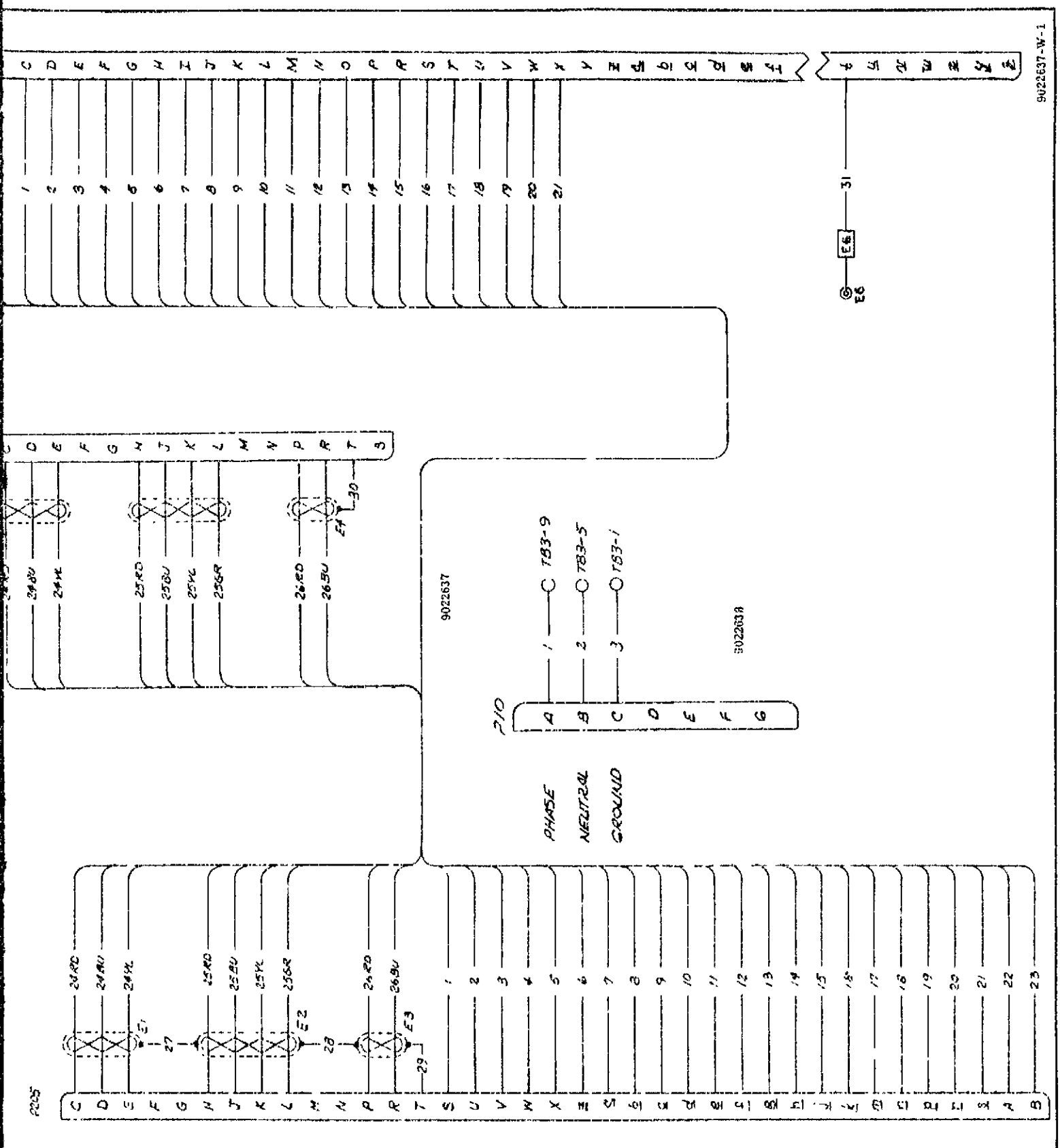


Figure 12-13. Electrical Cable Wiring Diagrams (Sheet 7 of 8)

The following cables are wired between pins of the same identification in both connectors: (Cables with shields are wired as shown.)

Cable Part Number	Remarks
9022639	--
9022642	--
9022644	P209-C is wired to shield 1BU-1RD.
	P207-F is wired to shield 2BU-2RD.
	P207-G through P207-R are not wired.
	P302-C is wired to shield 1BU-1RD.
	P303-C is wired to shield 2BU-2RD.
9022648	Pin A phase.
	Pin B neutral.
	Pin C ground.
9022649	--

Figure 12-18. Electrical Cable Wiring Diagrams (Sheet 8 of 8)

12-46. CALIBRATION REQUIREMENTS.

12-47. The console gages, flowmeters, voltmeter, and ammeter must be checked against a known standard to determine their accuracy. Calibrating procedures and requirements are given for the temperature indicators. Operating and servicing manuals supplied with the console contain calibration requirements for the digital voltmeter and oscilloscope.

12-48. CHECKING PRESSURE GAGES. See figure 12-18A for pressure gage calibration check requirements. All gages listed in figure 12-18A are used in pneumatic systems.

Part Number	Nomenclature	Range/Accuracy (+ Full Scale)	Test Standard[a] Minimum Accuracy (+ Full Scale)
19-9021929-3	SOURCE PRESS	0-10,000 psig (2%)	0.8%
19-9017879-2	SYST SUPPLY PRESS	0-10,000 psig (2%)	0.8%
601377TASX2 PEOG	REG SUPPLY PRESS	0-6,000 psig (0.25%)	0.1%
19-9021929-3	REG SUPPLY PRESS	0-2,000 psig (0.25%)	0.1%
19-9021929-1	REG SUPPLY PRESS	0-160 psig (0.25%)	0.1%
19-9021928-2	TEST CELL MONITOR PRESSURE	0-2,000 psig (0.1%)	0.04%
19-9021934-1	PRESSURE DIFFERENTIAL	0-60 psig (0.5%)	0.2%
19-9021928-1	PRESSURE/FLOW MONITOR	0-1,000 psig (0.1%)	0.04%
19-9021929-2	PRESSURE MONITOR "A"	0-600 psig (0.25%)	0.1%
19-9021929-2	PRESSURE MONITOR "B"	0-600 psig (0.25%)	0.1%
19-9021928-3	PRESSURE	0-6,000 psig (0.1%)	0.04%
19-9021929-4	REG SUPPLY PRESS	0-1,500 psig (0.25%)	0.1%

(a) Range of test standard must be at least 100% but not more than 125% of range of instrument being tested.

Figure 12-18A. Pressure Gage Calibration-Check Requirements

12-49. CHECKING FLOWMETER. Flowmeters must be checked for accuracy using helium or gaseous nitrogen that meets requirements specified in section I, as the pressurizing agent. Flowmeter must be accurate (within 2 percent of full scale). Flowmeter being checked must indicate within specified degree of accuracy; otherwise calibrate or replace it with a flowmeter that is within specified degree of accuracy.

12-50. (Deleted)

12-51. CALIBRATING OSCILLOSCOPE. The oscilloscope must be calibration-tested as outlined in the Model 120B (Hewlett Packard Co) operating and servicing manual stored in the components test console.

12-52. CALIBRATING DIGITAL VOLTMETER. The digital voltmeter must be calibration-tested as outlined in the Model DY2401B (Dymec Division of Hewlett Packard Co) operating and servicing manual stored in the components test console.

12-53. CHECKING VOLTMETERS AND AMMETER. The voltmeters and ammeter must be checked to ensure an accuracy of 0.5 percent of full scale. These instruments need not be removed from panel to be tested, since the test values can be applied to the instruments using a patch-board. To determine necessary patching, see figure 12-10. Noting positive or negative value of connection D for each instrument reveals the required current flow. The valve opening percent meter must be checked to ensure an accuracy of 2.5 percent of full scale. Test values are applied to the meter calibrate jacks on the face of the panel. (The red jack is positive.)

12-54. CALIBRATING TEMPERATURE INDICATORS. Information for calibrating channel number 1 is not supplied, since the components necessary to utilize the channel are not incorporated in console. Procedures are identical for calibrating channels 2 (low-flow) and 3 (high-flow), except for the position of the CHANNEL SELECT switch, the temperature transducer utilized, and the potentiometers adjusted. The following procedures calibrate channel 2; to calibrate channel 3, substitute 3 position of CHANNEL SELECT switch, P18 temperature transducer, and number 3 SENS ADJ. and ZERO ADJ. potentiometers.

a. Obtain universal test lead kit 699 from components adapter set 9016796 and equipment capable of providing a controlled temperature environment of 30° to 35° F and 95° to 100° F and measuring these temperatures to an accuracy of 1° F.

b. Prepare console for electrical use (paragraph 12-27). This procedure does not require power at the 115 VAC 30 AMP electrical outlets; therefore, CIRCUIT BREAKER on test cell utility panel need not be depressed.

c. Momentarily depress ON-STANDBY switchlight. ON light goes off and STANDBY light comes on.

d. Turn VOLTS RANGE SELECT switch on ELECTRICAL CONTROL panel to C(0-75).

e. Pull out ELECTRICAL CONTROL panel.

f. Obtain suitable test leads and probes from universal test lead kit and interconnect OUT + terminal of PS2 power supply to A2-2A, and OUT - terminal to

A2-2E. Do not remove existing leads to PS2 power supply. Make electrical contact to these connectors by inserting probe between plastic sleeve and electrical lead and contacting metallic portion of connector.

g. Momentarily depress ON-STANDBY switchlight on ELECTRICAL CONTROL panel. STANDBY light goes off, ON light comes on, and VOLTS meter must indicate less than 30 volts. If VOLTS meter indication is greater than 30 volts, adjust PS2 power supply until VOLTS meter indicates less than 30 volts. (Adjustment screw for PS2 power supply is accessible through small hole below IN and OUT connections.)

h. (Deleted)

i. Turn VOLTS RANGE SELECT switch on ELECTRICAL CONTROL panel to D (0-30).

j. Check VOLTS meter. Meter must indicate 27.5 to 28.5 volts. Adjust power supply to obtain required reading.

k. Momentarily depress ON-STANDBY switchlight. ON light goes off, STANDBY light comes on, and VOLTS meter indicates zero.

l. Remove test probes.

m. Close ELECTRICAL CONTROL panel.

n. Momentarily depress ON-STANDBY switchlight. STANDBY light goes off and ON light comes on.

o. Remove low-flow temperature transducer (P15) and subject it to an environment of 30° to 35° F. Protect opened port from contamination.

p. Move CHANNEL SELECT switch to 2.

q. Adjust ZERO ADJ. number 2 potentiometer as required to obtain same temperature reading as indicated on calibration equipment.

r. Increase temperature applied to transducer to 95° to 100° F.

s. Adjust SENS ADJ. number 2 potentiometer as required to obtain same temperature reading as indicated on calibration equipment.

sA. Lubricate (Method VII, section I) temperature transducer packing with lubricant grease RP0140-012 (Rocketdyne) and install packing on temperature transducer.

sB. Lubricate (Method I, section I) temperature transducer boss with lubricant grease RB0140-012 (Rocketdyne).

t. Reinstall temperature transducer. Torque temperature transducer to 180-200 inch-pounds.

u. Repeat steps o through t, substituting (P18) for (P15) in step o, and 3 for 2 in steps p, q, and s.

v. After calibration, seal by any locally acceptable method, power supply PS2 adjustment screw and ZERO and SENS ADJ. potentiometers for channels 2 and 3.

w. Pressurize LOW FLOW and HIGH FLOW systems with helium to 960-980 psig and check for leakage at transducer-to-boss parting surfaces. Use leak-test compound (MSFC-SPEC-364). No leakage is allowable as indicated by absence of bubble growth over a 5-minute period. ▮

12-55. FILLING HYDRAULIC RESERVOIR.

12-5f. Add Kel-F No. 10 heavy oil (Minnesota Mining and Mfg) to the hydraulic reservoir when fluid level is not visible in reservoir sight gage.

a. Disconnect line between HYD RESERVOIR VENT outlet and hydraulic reservoir at reservoir.

b. Add fluid to reservoir through opened port until level of fluid is visible in sight gage located on end of reservoir.

c. Connect hydraulic reservoir vent line to reservoir.

d. Torque vent line coupling nut to 135-185 inch-pounds.

12-57. PREPARING FOR STORAGE.

12-58. the console is to be relocated for storage, it is recommended that the console be stored in a sheltered area to prevent undue contamination and corrosion. The control console and test cell must be separated to enable the console to be moved (paragraph 12-59).

a. Close test cell cover.

b. Ensure that all connections are pressure-capped.

c. Enclose control console and 278 units of desiccant (MIL-D-3464) within moisture proof barrier material (MIL-B-131, Class 1), or equivalent and containing a humidity indicator 827526 (Humidial Co) or equivalent. Seal at bottom edge.

d. Enclose test cell and 360 units of desiccant (MIL-D-3464) within moisture proof barrier material (MIL-B-131; Class 1), or equivalent, and containing a humidity indicator 827526 (Humidial Co) or equivalent. Seal at bottom edge.

12-59. PREPARING FOR SHIPMENT.

12-60. The components test console test cell and control console must be separated to enable it to be moved or shipped. The oscilloscope panel must be removed for shipping.

a. Close test cell cover.

b. Remove blank panels above POWER DISTRIBUTION panel and below test cell utility panel.

c. Disconnect 2 tube assemblies from LN_2 LEVEL indicator gage and cap open ports.

d. Disconnect 2 electrical plugs P36 and P37 from receptacles J36 and J37.

e. Remove test cell utility panel.

f. Remove clamps securing tube assemblies (figure 12-5). Store in console storage drawer.

g. Remove interconnecting tube assemblies (figure 12-5) between pneumatic console and test cell. Cap all open tube assemblies.

h. Store interconnecting tube assemblies in console storage drawer.

i. Disconnect electrical connectors P701, P702, and P703 from receptacles on control console bracket. Cap receptacles and connectors and secure wire harnesses.

j. Remove clamp securing oscilloscope power supply cord.

k. Disconnect oscilloscope power supply cord from receptacle J604B on side strut of pneumatic console.

l. Disconnect electrical plugs P302 and P303 from oscilloscope receptacles.

m. Remove oscilloscope panel from console.

n. Disconnect and store facility power cables from receptacle J7 and J8 and store in console storage drawer.

o. Disconnect 2 facility pressure tube assemblies and store in console. Fittings on facility tube assemblies are necessary for reinstallation of console.

p. Disconnect vent lines from HYD RESERVOIR VENT, DECK DRAIN, LN_2 RETURN, and LN_2 VENT lines at rear of test cell. Cap fittings.

q. Install plug in bottom of MEDIUM PRESSURE panel regulator.

r. Install plugs or protective closures in all vent and relief valve outlets except relief valves in LN_2 vent system located below test cell. For location of vent and relief valves, see figure 12-6.

s. Install test cell utility panel on front of test cell.

t. Connect tubing assemblies to each side of LN_2 LEVEL indicator gage. Torque nuts to 135-185 inch-pounds.

u. Connect plug P36 to receptacle J36 and plug P37 to receptacle J37 on test cell utility panel.

12-61. MAINTENANCE OF COMPONENTS TEST CONSOLE COMPONENTS.

12-62. Maintenance of components consists of adjusting flow control valves, relief valves, pressure switches, cover stop switch, and testing patch-cords and lubricating test cell cover and console hand valves.

12-63. ADJUSTING FLOW CONTROL VALVES.

12-64. A flow control valve is installed in each line attached to the hydraulic actuators. These valves incorporate a variable orifice by which the opening and closing rate of the test cell cover is controlled.

a. Loosen locknut on flow control valve.

b. With hydraulic oil warmed up, turn adjustment screw until test cell cover opens in 25-40 seconds and closes in 25-40 seconds. Turn screw clockwise to decrease flow.

NOTE

If adjusting a newly-installed flow control valve, a nominal position can be obtained by turning adjusting screw fully clockwise then one-eighth turn counterclockwise.

c. Hold flow control valve adjustment screw and tighten locknut.

12-65. ADJUSTING RELIEF VALVES.

12-66. Adjust relief valves as follows:

a. Remove end cap from relief valve.

b. Loosen locknut on adjusting screw.

c. Adjust relief valve within 3 percent of required setting. Last group of numbers of valve part number is required setting. Turn adjusting screw clockwise to increase relief valve setting, or counterclockwise to decrease setting.

d. Hold adjusting screw and tighten locknut.

e. Install end cap on relief valve.

12-67. ADJUSTING PRESSURE SWITCHES.

12-68. Adjust pressure switches as follows:

a. Loosen setscrew securing adjusting screw.

b. Turn adjusting screw in INCR direction or in DECR direction, as required, to obtain switch actuation at 50 ±15 psig while increasing pressure.

c. Tighten setscrew sufficiently to prevent inadvertent movement of adjusting screw.

12-69. ADJUSTING TEST CELL COVER STOP SWITCH.

12-70. Adjust test cell cover stop switch up or down on its attaching bracket, as required, to cause it to actuate and stop the test cell cover with a minimum clearance of 0.025 to 0.040 inch at any point between hinges and stop pads.

CAUTION

Ensure that test cell cover does not open far enough during adjustment to allow hinges to contact stops, since damage to hinges can result.

12-71. TESTING PATCH-CORDS.

12-72. Testing patch-cords (figure 12-3) consists of a continuity- and resistance-test.

a. Check all K2 and K9 patch-cords for continuity.

b. Check for 646-714 ohms across the following leads of resistor patch-cord 3088-1:

(1) Yellow to red.

(2) Yellow to blue.

(3) Blue to black.

c. Check for 58-65 ohms across resistor patch-cord 3088-3.

d. Check for 95K to 105K ohms across resistor patch-cord 3088-5.

e. Check for 950-1050 ohms across the following leads of resistor patch-cord 3088-6:

(1) Yellow to red.

(2) Yellow to black.

f. Check range of resistor patch-cord 3088-2. Range must be at least 1-50K ohms. Resistance value must increase and decrease smoothly with potentiometer adjustment.

g. Check range of resistor patch-cord 3088-4. Range must be at least 1-200K ohms. Resistance value must increase and decrease smoothly with potentiometer adjustment.

12-73. LUBRICATING TEST CELL LATCH AND HINGES.

12-74. The test cell latch assembly and cover hinges must be lubricated with gear grease (MIL-G-23827). The test cell latch assembly cover must be removed to gain access to latch assembly lubrication points.

12-75. LUBRICATING HAND VALVES.

12-76. Hand valves (except cryogenic valves) must be lubricated in accordance with the following procedure: (Valves developing symptoms of binding between lubrication periods must not be operated, or permanent damage to internal parts will result. Valves must be re-lubricated immediately. See figure 12-19 for identification of valve parts. A loose seat packing screw may cause an internal leak in the hand valve. The screw torque may be checked using this procedure.)

a. Make sure there is no pressure locked up by valve to be lubricated. See pneumatic schematic (figure 12-8) for determining presence and means of venting locked up pressure.

NOTE

Steps b through l provide requirements for 1/4-inch valves. Steps m through v provide requirements for 1/2-inch valves (the SHUTOFF valve on the MEDIUM PRESSURE panel and the outermost valve on each side of the PRESSURE/FLOW MONITOR panel).

b. Remove control knob, sleeve, and stem. Hold retainer when removing sleeve to prevent torque loads from being transmitted to attaching lines.

c. Clean sleeve and stem. Refer to section I for cleaning requirements. Do not clean remainder of valve unless known contamination exists or excessive grease is apparent. If further cleaning is not required, proceed to step e.

NOTE

Grease is considered excessive when the possibility exists of introducing it into the system when the valve is reassembled.

d. If further cleaning is required, remove remainder of valve from console and clean in accordance with section I. After cleaning, lubricate (Method J, section I) retainer packing, and lubricate (Method A, section I) retainer threads with lubricant grease RB0140-012 (Rocketdyne). Install packing on retainer, and assemble retainer and body on console. Torque retainer to 25-35 foot-pounds.

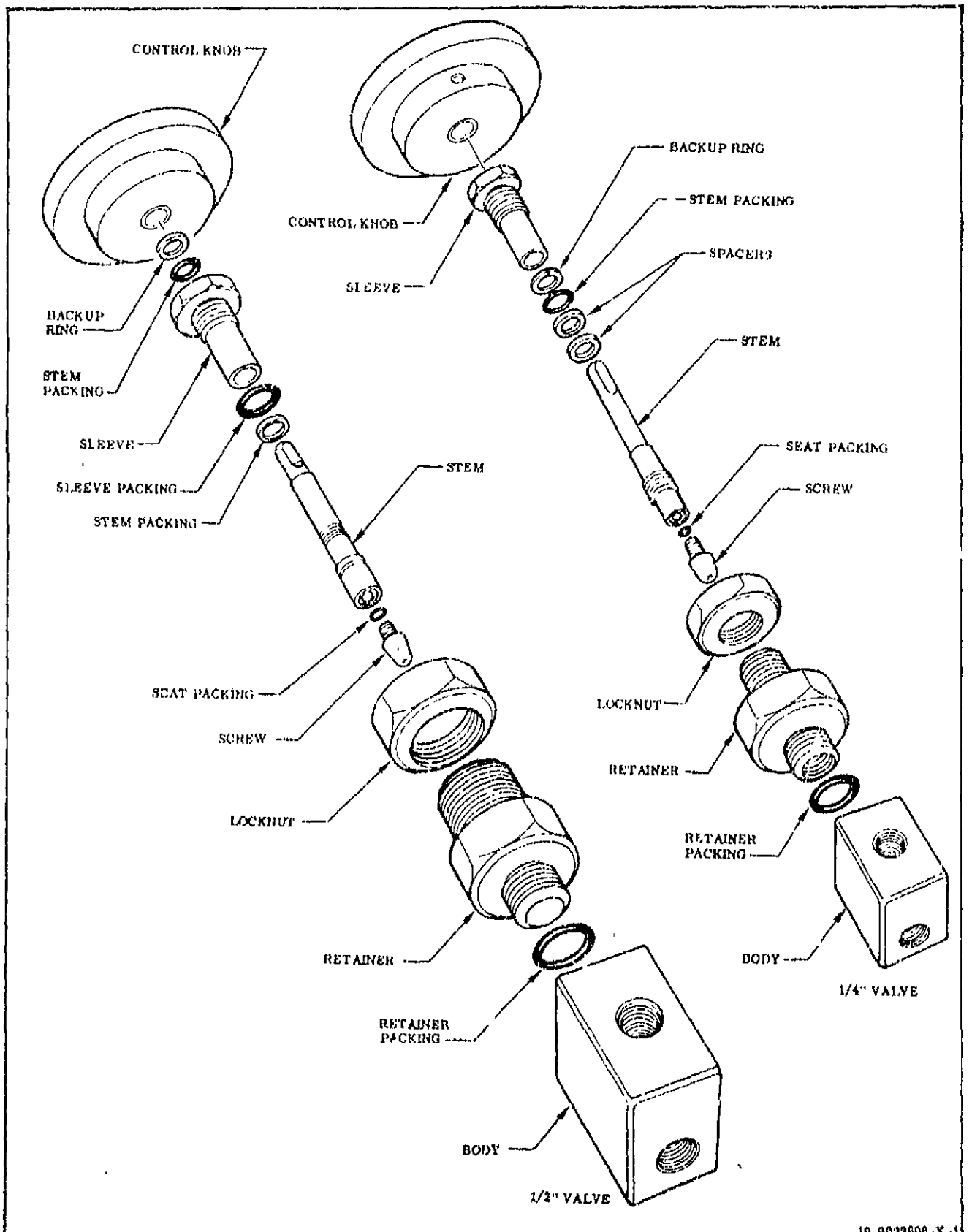


Figure 12-19. Hand Valve Lubrication

e. Replace defective stem or seat packing. It is preferable to replace used packings, even though they appear not to be defective; however, reuse is not detrimental unless packings are visibly damaged or are known to have failed. Lubricate (Method L, section I) only existing or replacement stem packing with lubricant grease RB0140-012 (Rocketdyne). If seat packing is replaced, torque screw to 11-13 inch-pounds. If seat packing has not been replaced, check screw torque. Torque must be 11-13 inch-pounds.

f. Apply 2 streaks of lubricant grease RB0140-012 (Rocketdyne) to stem threads. Streaks are to be 1/8 to 1/4 inch wide, flush with thread peaks, and approximately 180 degrees apart. Apply 3 streaks approximately 120 degrees apart if valve was removed from console and cleaned (step d).

g. Insert and fully thread stem into valve body, and remove stem.

h. Without removing any grease from stem threads, reapply grease (step f). Remove grease buildup on stem, seat packing, or screw.

i. Insert and thread stem fully into valve body.

j. Lubricate (Method A, section I) sleeve with lubricant grease RB0140-012 (Rocketdyne). Install and torque sleeve to 10-20 foot-pounds. Hold retainer while torquing to prevent loads from being transmitted to attaching lines.

k. Install control knob, and tighten setscrews.

l. Test valve with operating pressure of system in which it is installed. No leakage is allowable, internally or externally. Check for external leakage using leak-test compound (MSFC-SPEC-384). Check for internal leakage using pressure buildup or decay method. Internal leakage may be due to a loose seat packing screw. (Refer to step e.)

NOTE

No leakage is defined as no increase in bubble size or pressure change in a 5-minute period.

- The remainder of this procedure provides requirements for 1/2-inch valves.

m. Remove control knob, sleeve, and stem. Sleeve has left-hand threads. Hold retainer when removing sleeve, to prevent torque loads from being transmitted to attaching lines.

n. Clean sleeve and stem. Refer to section I for cleaning requirements. Do not clean remainder of valve unless known contamination exists or excessive grease is apparent. If further cleaning is not required, proceed to step p.

NOTE

Grease is considered excessive when the possibility exists of introducing it into the system when valve is reassembled.

o. If further cleaning is required, remove remainder of valve from console and clean in accordance with section I. After cleaning, lubricate (Method J, section I) retainer packing, and lubricate (Method A, section I) retainer threads with lubricant grease RB0140-012 (Rocketdyne). Install packing on retainer, and assemble retainer and body on console. Torque retainer to 35-45 foot-pounds.

p. Replace defective stem or seat packings. It is preferable to replace used packings, even though they appear not to be defective; however, reuse is not detrimental unless packings are visibly damaged or are known to have failed. Lubricate (Method L, section I) only existing or replacement stem packing with lubricant grease RB0140-012 (Rocketdyne). If seat packing is replaced, torque screw to 11-13 inch-pounds. If seat packing has not been replaced, check screw torque. Torque must be 11-13 inch-pounds.

q. Apply 3 streaks of lubricant grease RB0140-012 (Rocketdyne) to stem threads. Streaks are to be 1/8 to 1/4 inch wide, flush with thread peaks, and approximately 120 degrees apart.

r. Insert and fully thread stem into sleeve, and remove stem.

s. Without removing any grease from stem threads, reapply grease (step q). Remove grease buildup on stem and sleeve and reapply to stem threads.

t. Repeat steps r and s until a film of grease covers all active threads in sleeve. Remove grease buildup on stem and sleeve when lubrication is complete.

tA. Lubricate (Method A, section I) sleeve, and lubricate (Method J, section I) sleeve packing with lubricant grease RB0140-012 (Rocketdyne).

u. Assemble stem, sleeve, and control knob. Torque sleeve to 15-25 foot-pounds. Hold retainer while torquing to prevent torque loads from being transmitted to attaching lines.

v. Test valve with operating pressure of system in which it is installed. No leakage is allowable, internally or externally. Check for external leakage, using leak-test compound (MSFC-SPEC-384). Check for internal leakage, using pressure build-up or decay method. Internal leakage may be due to a loose seat packing screw. (Refer to step e.)

NOTE

No leakage is defined as no increase in bubble size or pressure change in a 5-minute period.

SECTION XIII

AUTOMATIC INERT GAS ARC WELDING SET G3128

WARNING

AUTOMATIC INERT GAS ARC WELDING SET G3128 AND SINGLE HEAD SPECIAL TOOL KIT G3127 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

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	13-46	Proof-Pressure-Testing Hoses	13-47

13-1. DESCRIPTION AND LEADING PARTICULARS.

13-2. The Automatic Inert Gas Arc Welding Set (figure 13-2) provides and controls the power, current, and inert gas purge to the welding head electrode tip (section XIV) to perform melt-thru and lap-fillet in-place tube welding. The 200-ampere welding set power supply unit is capable of operating at voltages of 230 or 460 vac, three phase, 60 cps, with a current capacity of 3-200 amperes and duty cycles limited to 60 percent at 200 amperes and 100 percent at 100 amperes. The welding set power supply unit also provides six instrumentation terminals which can be used to permanently record the welding current, welding voltage, and a 24-volt, 60-cycle reference trace. The ammeter range selector switch selects the current range at which the ammeter on the welding set power supply unit will safely indicate the current applied. Three voltage compensators maintain a constant input voltage of 230 or 460 vac ± one percent to the welding set power supply unit. A high-frequency unit, attached to the welding set power supply terminals, provides up to 3.5 megacycles per second to establish an arc between the welding tip and the material to be welded. The programmer, consisting of pre-flow and post-flow gas purge timers, a weld-duration timer, a fixture-delay timer, and a sequence-stop timer, controls the weld sequence. The slope control unit, containing start and tail slope current and time adjustments, controls the rate of upslope current change between initial start current and welding current, and downslope current change between welding current and zero current. The low-current switch and low-current adjustment control permit the welding set to weld at currents below ten amperes. A water-cooling system, consisting of a water tank, a motor-operated pump capable of delivering two gpm at 50 psig, a flow indicator, and a water-level gage, cools the welding cables performing welds at currents greater than 125 amperes. The controller provides speed control for the weld heads. The purge panel maintains a pre-set differential between the head and tube pressures, effecting a gas jig for the weld melt which results in welds that are relatively flat at both the outer and inner surfaces. An insulated ground strap with a screw-type attach clamp provides an external safety ground if a defective facility ground exists. Each unit incorporates a mobile base, a cover, a lifting sling, a cable and hose support, a container for accessories and tools, right-angle position tools, and an instrumentation adapter. The controller cable provides an electrical plug for disconnection from the welder. A fixture timing switch, current-sensing relay, and cables are included. Outriggers on the purge panel provide stabilization when the panel is used away from the welder. Filters and dehydrators provide clean, dry purge gases. See figure 13-3 for leading particulars.

Pages 13-3 and 13-4, figure 13-1, deleted.

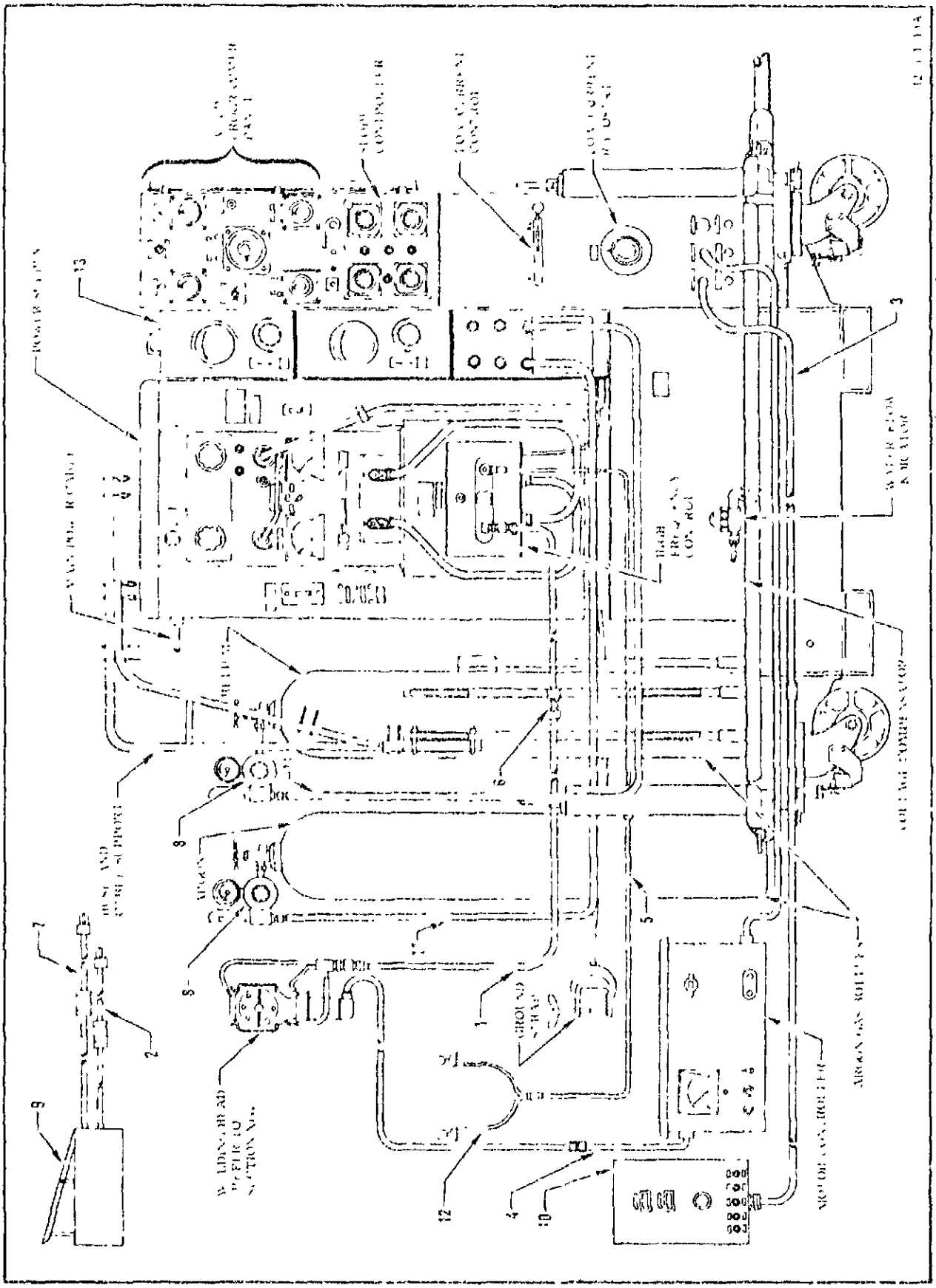


Figure 13-2. Automatic Inert Gas Arc Welding Set (Sheet 1 of 2)

Index Number	Part Number	Nomenclature	Quantity (One each except as noted.)
	G3128	Automatic Inert Gas Arc Welding Set	
1	65396	Cable	4
2	TWH200-11	Cable Assembly	2
3	TWH200-18	Cable Assembly	3
4	TWH200-21	Cable Assembly	4
5	TWH200-27	Cable Assembly	4
6	65400	Cable Adapter	
7	TWH200-9	Cable Assembly	2
8	34-1181	Gas Supply Regulator and Flowmeter	2
9	52C28-4	Foot Control	
10	52C56-3	Hand Remote Control	
11	9027422	Supply Hose	2
12	9027439	In-Place Welding Ground Cable	
13	9027440-11	Pressure Control Purge Panel	

Figure 13-2. Automatic Inert Gas Arc Welding Set (Sheet 2 of 2)

Height	78.0 ±1 inches
Length	74.5 ±1 inches
Length with tow bar extended	113.7 ±1 inches
Width	53.0 ±1 inches
Weight[(a)]	1,550 pounds (approximately)
Welder with gas bottles	1,890 pounds (approximately)
Welder Base	710 pounds (approximately)
Welder, Base, and Gas Bottles	2,600 pounds (approximately)
Towing Speed	2.5 miles per hour maximum
Sling Working Load	3,500 pounds
Wheel Size	8 inches
Power	
Input Voltage	230/460 ±5%-vac, 3-phase, 60-cycle
Input Current per Phase	42 amperes at 230 vac 21 amperes at 460 vac
Welding Current Range	3 amperes, at 20 load volts minimum 250 amperes, at 40 load volts maximum
Open Circuit Voltage at Welding Terminals	70-80 vdc
Primary kva at Rated Load	18 kva
Primary Power at Rated Load	14 kilowatts
Efficiency	100 percent at 100 amperes 60 percent at 200 amperes

(a) Without water in hydromount

Figure 13-3. Leading Particulars (Sheet 1 of 2)

Power Factor	0.76
Auxiliary Transformer	2 kva
Main Cable Wire Size	No. 8 AWG at 230 vac No. 12 AWG at 460 vac
Main Circuit Breaker	100 amperes
Voltmeter	0-100 vac accuracy ±1 percent
Ammeter	0-250 amperes accuracy ±1 percent
Instrumentation Terminals	6 required
Pre-Flow Timer	0-10 minutes
Post-Flow Timer	0-30 seconds
Fixture-Delay Timer	0.50-30 seconds
Sequence-Stop Timer	1-30 seconds
Weld-Duration Timer	0.75-300 seconds
Welding-Current Response	10 cycles or less
Output-Current Variation	2 percent maximum for 60 minutes
Hydromount	
Water Tank Capacity	25 gallons
Water Pump Capacity	2 gpm at 50 psig
Gas Bottle Storage Capacity	4 gas bottles
Remote Controls	
Hand-Operated	
Voltmeter	0-100 vac
Ammeter	0-200 amperes
Cable Connector	quick-disconnect
Foot-Operated	
Cable Connector	3-prong, twist-lock
Weld Head Speed Control	
Cable Connector	quick-disconnect

Figure 13-3. Leading Particulars (Sheet 2 of 2)

13-3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

13-4. The modifications incorporated changing configuration of the automatic inert gas arc welding set are listed in figure 13-4.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-295	1,2	29 March 1965
J2-517	3	8 June 1966
J2-554	4	14 March 1967
J2-563	5	14 March 1967
J2-517R1	3	15 May 1967
J2-596	6	20 March 1968
J2-718	8	2 March 1973

Figure 13-4. Configuration Changes--Manual Effectivity

13-5. THEORY OF OPERATION.

13-6. With the welding set prepared for operation and controls set to perform a weld, facility power is supplied to the main circuit breaker. Closing the main circuit breaker provides power to the electrode through the high-frequency oscillator, the programmer, the slope-control signal and power circuits and the fixture-motor control circuits. Pressing the start button on the remote control unit activates the program circuitry, which begins the operation sequence (figure 13-5). The shielding gas flow is initiated manually, and the pre-flow timer starts and ensures an adequate purge before the weld cycle begins. After the pre-flow timer has elapsed, the high-frequency oscillator is activated by a signal, which causes the arc to strike. The purge gases controlled by the pressure control purge panel regulator are vented through an orifice in the purge hose adapter during the weld cycle. The voltage drop created by the arc enables a signal to deactivate the high-frequency oscillator, starting the fixture-delay timer and slope controller and injecting a signal into the magnetic amplifier reactor for up-slope control. The output current rises to welding current level. The time elapse of the fixture-delay timer causes the weld-duration timer to start and the fixture motor to run. When the weld-duration timer expires, the sequence-stop timer is activated and a signal activates the slope controller to inject a signal into the magnetic amplifier for down-slope control. The output current of the welder gradually decreases to final-current levels until the sequence-stop timer expires. The time elapse of the sequence-stop timer starts the post-flow timer, removes power from the welder output circuit. The purge gases continued to flow until turned off manually.

13-7. ACCESSORIES.

13-8. Accessories, such as remote control units and extension cables and hoses, are listed in figures 13-2 and 13-6. Index numbers in figure 13-6 indicate placement of accessories in container to facilitate use and prevent damage to accessories or container.

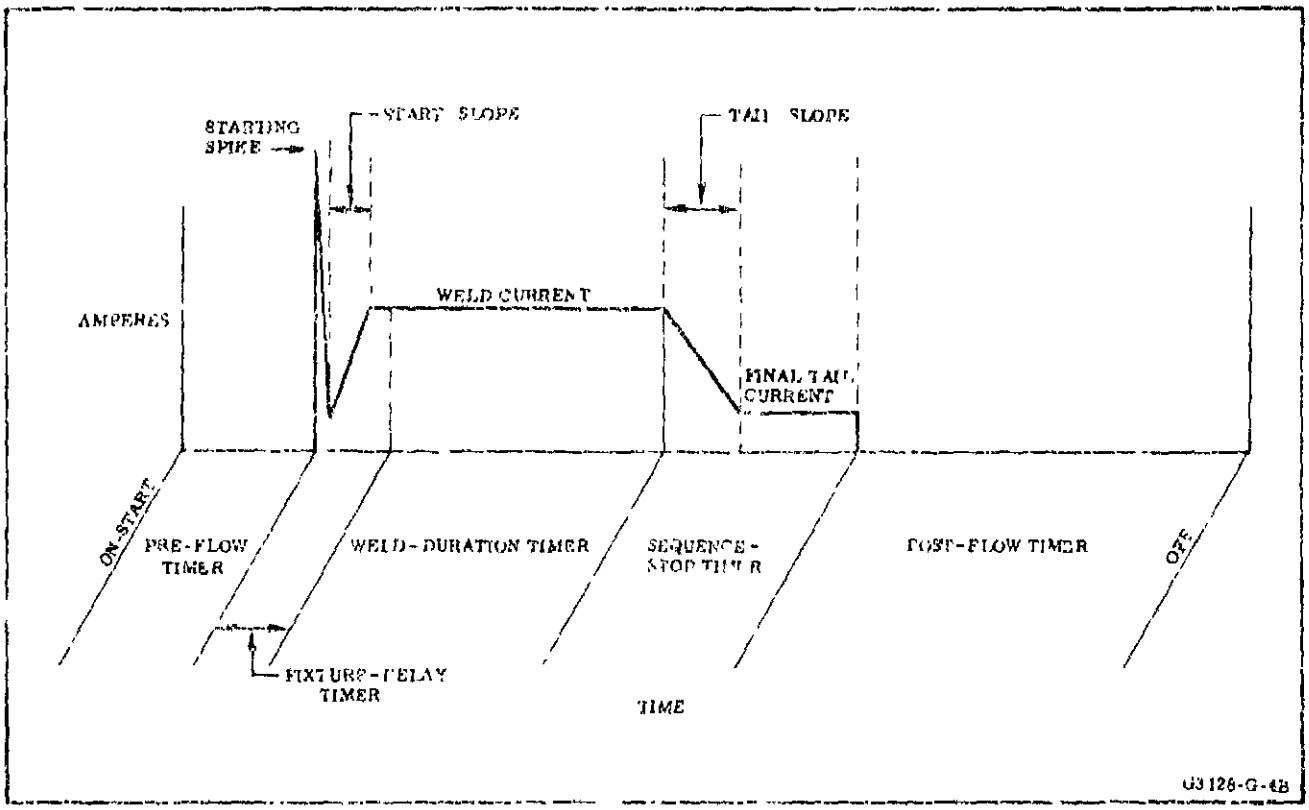
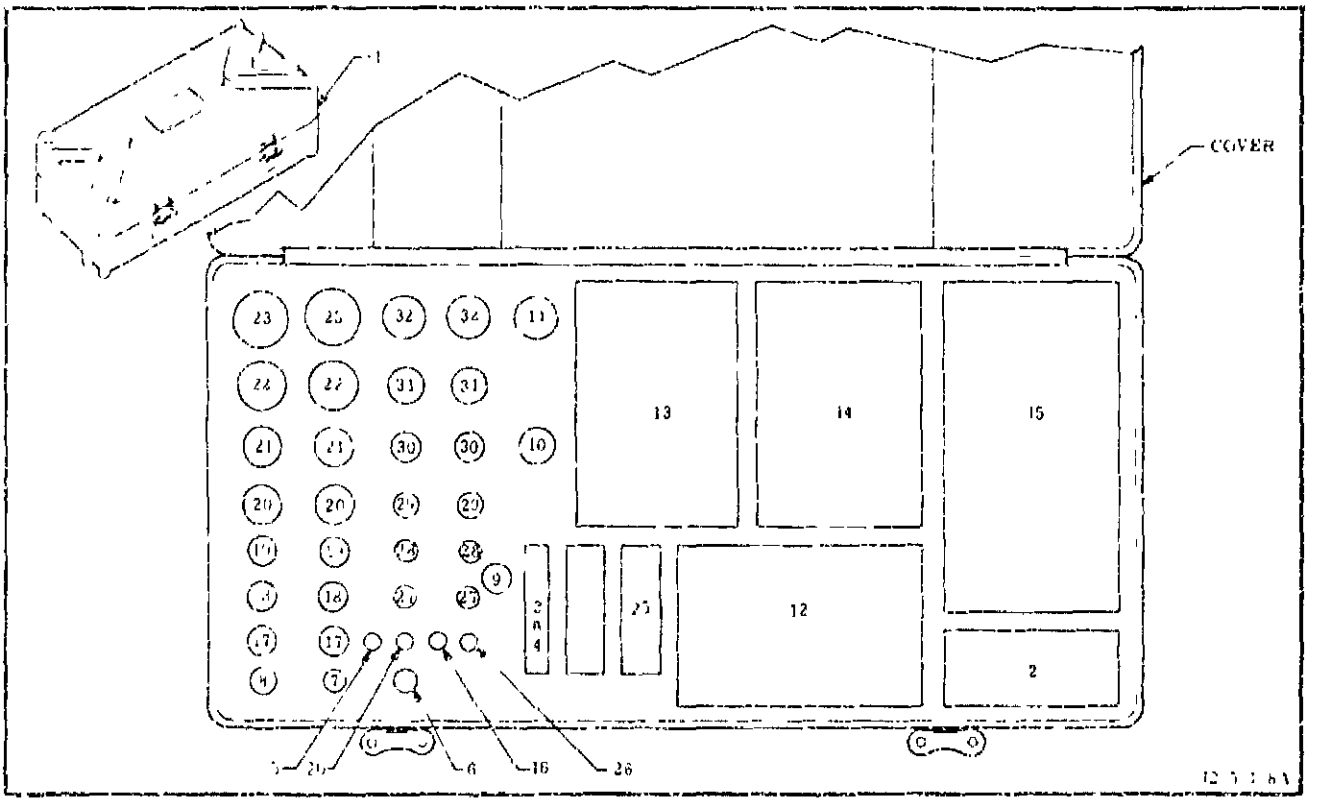


Figure 13-5. Sequence of Operation Chart



Index Number	Part Number	Nomenclature	Quantity (One each except as noted.)
	9027280	Connector	8
	9027381	Handling Sling	
	9027434-21	Accessories Container	
1	9027426	Container	
2	1704-5Y, -7Y, -9Y, -13Y, -17Y, -21Y, and -27Y	Tube Protector Cap	2
3	60 FL-1/8	Sleeve	
4	68 FL-1/8	Connector	
5	9027287	Right-Angle Position Tool	
6	9027287-11	Right-Angle Position Tool	
7	9027287-21	Right-Angle Position Tool	

Figure 13-6. Accessories (Sheet 1 of 3)

Index Number	Part Number	Nomenclature	Quantity (One each except as noted.)
8	9027287-31	Right-Angle Position Tool	
9	9027287-41	Right-Angle Position Tool	
10	9027287-51	Right-Angle Position Tool	
11	9027287-61	Right-Angle Position Tool	
12	9027288	Purge Adapter Kit	
	9027278	Adapter	
	NAS1004-14A	Bolt	3
	RD114-1002-0004	Nut	3
	RD153-1002-0004	Washer	3
	VD192-0005-0001	Container	
13	9027289	Purge Adapter Kit	
	9027281	Adapter	2
	VD192-0005-0001	Container	
14	9027290	Purge Adapter Kit	
	9027282	Adapter	
	9027284	Gasket	
	NAS1004-18A	Bolt	4
	RD114-1002-0004	Nut	4
	RD153-1002-0004	Bolt	4
	VD192-0005-0001	Container	
15	9027291	Purge Adapter Kit	
	9027285	Adapter	
	NAS1004-19A	Bolt	4
	RD114-1002-0004	Nut	4
	RD153-1002-0004	Washer	4
	VD192-0002-0844	Container	
16	9027292	Instrumentation Tube Adapter	
17	9027317-3	Tube In-Place Welding Adapter	

Figure 13-6. Accessories (Sheet 2 of 3)

Index Number	Part Number	Nomenclature	Quantity (One each except as noted.)
18	9027317-5	Tube In-Place Welding Adapter	2
19	9027317-7	Tube In-Place Welding Adapter	2
20	9027317-9	Tube In-Place Welding Adapter	2
21	9027317-13	Tube In-Place Welding Adapter	2
22	9027317-15	Tube In-Place Welding Adapter	2
23	9027317-17	Tube In-Place Welding Adapter	2
25	9027425	Head Purge Adapter	
26	9027438	Tube Position Tool	2
27	9027438-11	Tube Position Tool	2
28	9027438-21	Tube Position Tool	2
29	9027438-31	Tube Position Tool	2
30	9027438-41	Tube Position Tool	2
31	9027438-51	Tube Position Tool	2
32	9027438-61	Tube Position Tool	2
	9027447-11	Tube Purge Hose	
	9027448	Head Purge Hose	
	9027450	Hose	8
	VK193-0489	Cover	

Figure 13-6. Accessories (Sheet 3 of 3)

13-9. USING AUTOMATIC INERT GAS ARC WELDING SET.

13-10. Using the welding set consists of procedures for handling, pre-operating inspection, preparing for use, preparing welding set for manual or automatic tungsten inert gas welding, and in-place tube welding. Refer to R-3825-3 for instructions for in-place welding with the automatic inert gas arc welding set.

13-11. HANDLING.

13-12. The welding set utilizes a mobile base which allows it to be towed, fork-lifted, or lifted by a sling provided with the welding set. Refer to figure 13-3 for welding set weight and towing speed. The welding set and purge panel are handled by one of the following methods:

a. Tow welder from either end by attaching tow bar, locking casters opposite towbar in trail position, and leaving casters adjacent to tow bar free-swiveling. Maximum towing speed is 2-1/2 miles per hour. A safety chain must be used between welding set and towing vehicle.

(1) When manually moving welding set over rough surfaces, such as test stand grating, metal (or plywood) sheets may be placed on surfaces to provide a smooth floor.

(2) When moving welding set manually in a constricted location, steering may be controlled with a caster wrench, such as is indicated in figure 13-6A.

b. Fork-lift welder with a 5,000-pound minimum capacity fork-lift.

c. Lift welder using a 3,500-pound minimum hoist with sling provided attached to each of the 4 sling attach points. Welding set can be lifted with inert gas bottles installed.

CAUTION

Do not use the power supply lifting ring to lift the welding set or damage can occur. The ring is designed to support only the welder power supply portion and may fail under the load of the complete welding set.

d. Purge panel can be removed from welding set and operated near area in which weld is being performed. Purge panel is removed by loosening 3 quick-disconnect screws (lower front, lower rear, and upper rear), the lifting purge panel upward (approximately 3 inches) and out from welding set. Outriggers at either side of panel can be extended to stabilize purge panel. Outrigger springs must be depressed to retract outriggers.

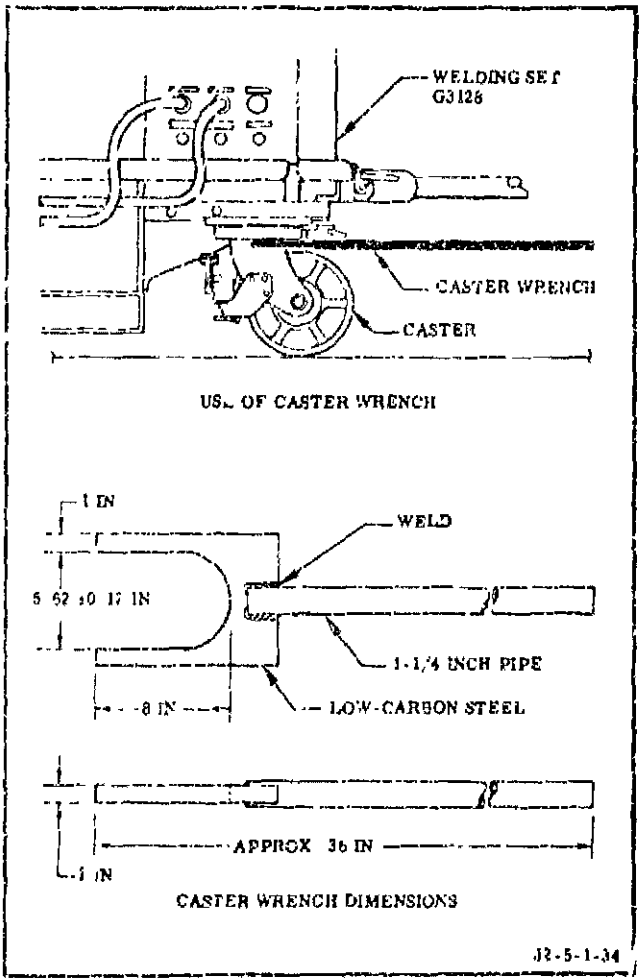


Figure 13-6A. Wrench for Steering Casters

e. Gas bottles on welding set must be secured in place with retaining chain at all times. When removing or replacing gas bottles, two men are required to lift each bottle. Slings to aid in lifting a gas bottle may be fashioned from 1/2-inch diameter rope (minimum) or 1-inch-wide flat nylon webbing, as indicated in figure 13-6B.

f. The purge panel and all purge gas hoses must be protected from contamination at all times by replacing purge panel port caps immediately whenever hoses are disconnected from panel, connecting purge hoses end to end, installing LOX-clean plugs into disconnected hoses or other suitable means to maintain cleanness.

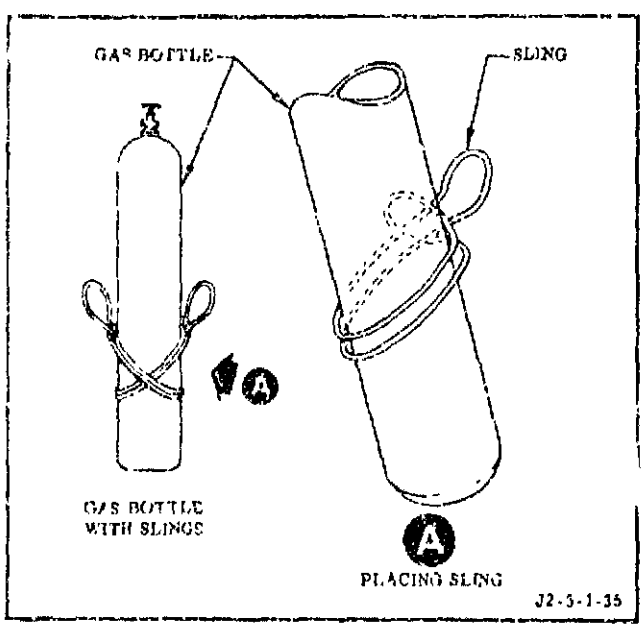


Figure 13-6B. Gas Bottle Handling Slings

Pages 13-16A and 13-16B deleted.

13-13. PRE-OPERATING INSPECTION.

13-14. The welding set, as received, is wired to operate on 460 vac. It can be wired to operate on 230 vac by changing the connections on the main terminal block (figure 13-7) located behind the high-frequency unit.

a. Remove top cover and side panels of welding set.

b. Using a multimeter set on ohm scale, check from main power cable connector to line side of voltage compensator and chassis ground for continuity. (See figure 13-15.) Ensure security of installation.

c. Carefully remove high-frequency unit from welding set power supply panel. Remove front panel from welding set to gain access to power supply terminal block.

CAUTION

The high-frequency unit is heavy. Handle with care to prevent damage.

d. Make sure all connections on terminal blocks are tight and welder power jumper links are arranged for same voltage as power source (230 or 460 vac), as shown in figure 13-7.

e. Replace panel removed in step c.

f. Remove cover from high-frequency unit and check spacing between high-frequency electrodes for 0.011 to 0.013-inch clearance. Reset spacing if necessary.

g. Reinstall cover on high-frequency unit.

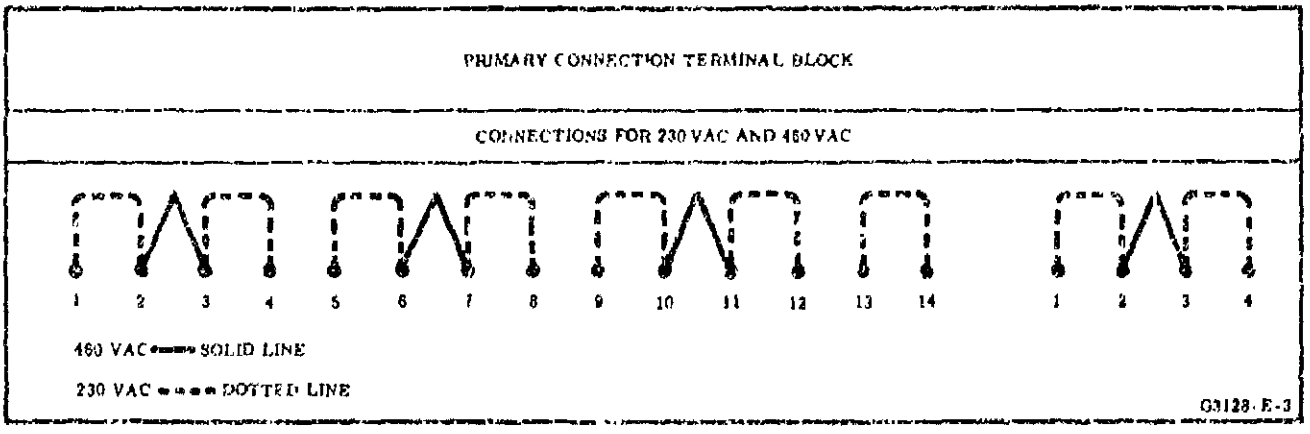

PRIMARY CONNECTION TERMINAL BLOCK
CONNECTIONS FOR 230 VAC AND 460 VAC
1 2 3 4 5 6 7 8 9 10 11 12 13 14
1 2 3 4
460 VAC SOLID LINE
230 VAC DOTTED LINE
G3128-E-3

Figure 13-7. Welding Set Power Supply Terminal Connection Block

h. Make sure all electrical terminal connections in welding set and sequence control panel are tight and undamaged.

i. Using a voltmeter capable of measuring 600 vac, measure voltage output of voltage compensator as follows: (See figures 13-8 and 13-15.)

WARNING

Operator must take precautionary measures to prevent injury from electric shock due to high voltage in the unit.

(1) Remove rear cover panel to voltage compensators.

(2) Connect main power cable to facility power supply.

(3) Connect ground strap to a facility ground.

(4) Move MAIN CIRCUIT BREAKER to ON.

(5) Measure voltage between X2 terminals on rear of voltage compensator units. Each voltage reading between the phases (A to B, A to C, and B to C) must be 230 ±2.3 vac or 460 ±4.6 vac. (See figure 13-7.) If voltage is not as specified, adjust voltage compensators as outlined in steps j through o.

NOTE

When adjusting voltage compensators, a comparison adjustment may be made by measuring voltage between X2 terminal and ground on each compensator. This voltage will be much lower than facility power but will read the same on each compensator when final adjustment is obtained.

j. Move MAIN CIRCUIT BREAKER to OFF.

k. Remove voltage compensator panel located above hydromount tank.

l. Loosen screw on each voltage compensator cage and open cages.

m. Move MAIN CIRCUIT BREAKER to ON.

n. Turn adjustment screw until 230 ±2.3 vac or 460 ±4.6 vac is indicated on voltmeter. (See figures 13-7 and 13-8.)

o. Repeat steps j through m until the 3 voltage compensators have been adjusted.

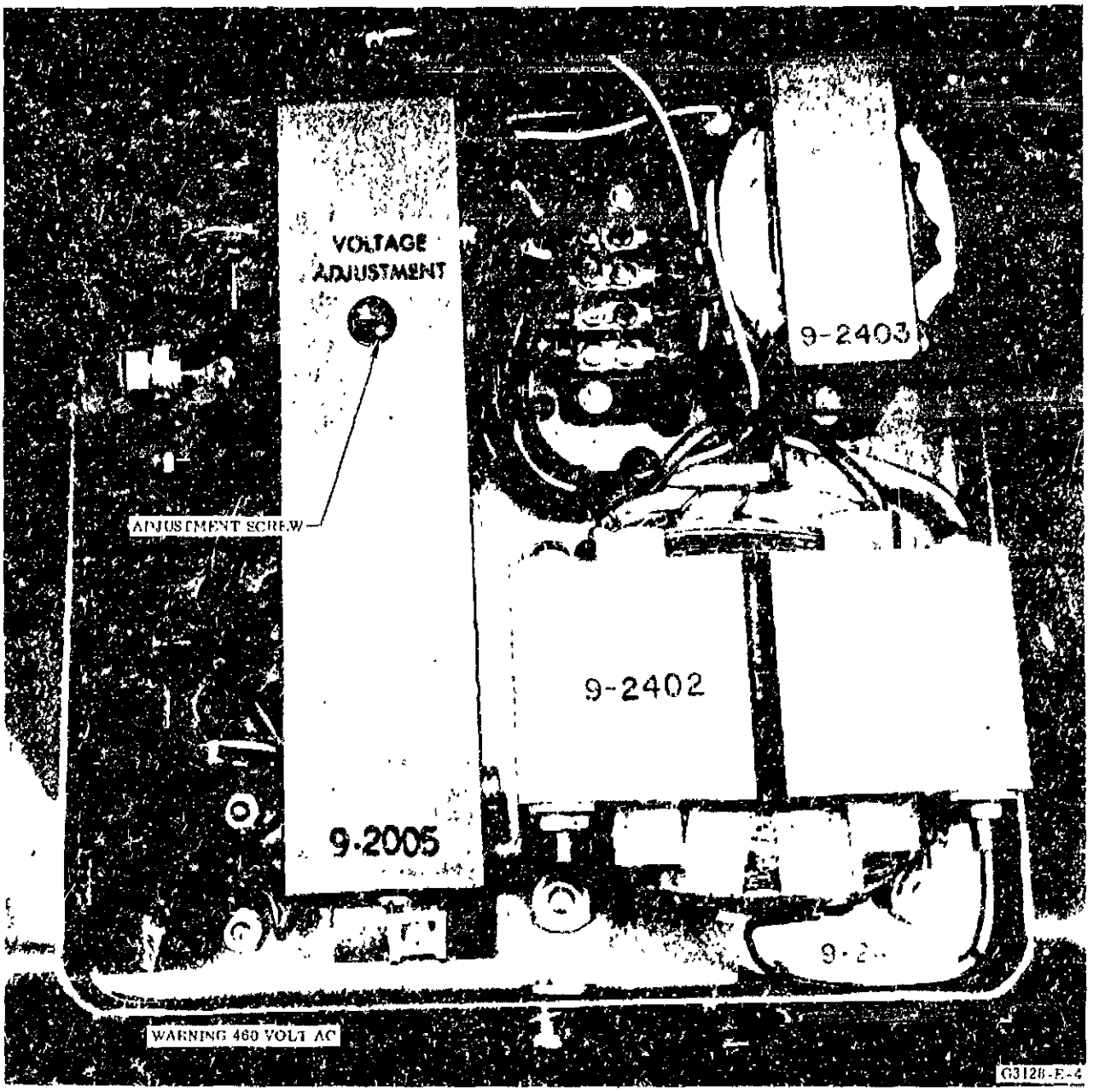


Figure 13-8. Welding Set Voltage Compensator Adjustment

p. Move MAIN CIRCUIT BREAKER to OFF and disconnect main power cable from facility connection. Disconnect ground strap from facility ground.

q. Close and secure voltage compensator cage and install cover panels on front and rear of welding set.

r. Install high-frequency unit on welding set power supply unit.

s. Install and secure top cover and side panels to welding set power supply unit.

t. If welding is to be performed at currents greater than 125 amperes, use water-cooled cables (not supplied) and fill hydromount tank with a minimum of 25 gallons of distilled water mixed with rust inhibitor Houghton grind No. 50 (Houghton Products) at a ratio of 50 parts water to one part inhibitor.

CAUTION

If welding set is used in below-freezing temperatures, the water in the hydromount tank and water-cooled hoses must be drained after use.

13-15. PREPARING FOR USE.

13-16. (Refer to R-3825-3.)

13-17. PREPARING FOR MANUAL TUNGSTEN INERT GAS WELDING.

13-18. Preparation of welding set for manual welding consists of preparing for use, connecting cables and purge hoses, and setting controls. The hand torch and water-cooled cables are not supplied with welding set. Refer to paragraph 13-13 for water-coolant requirements.

a. Connect argon supply to SHIELDING GAS IN inlet. Make sure gas cylinders have sufficient supply to provide necessary shielding gas.

b. Connect argon supply on torch to SHIELDING GAS OUT outlet.

c. If welds of long duration or above 125 amperes are to be made, connect water supply fitting on torch to WATER OUT outlet. Make sure water connections on hydromount are connected.

d. Connect torch electrical fitting to ELECTRODE on welder.

e. Connect foot control to CURRENT and CONTRACTOR outlets on welder.

f. Make sure MAIN CIRCUIT BREAKER, WATER PUMP, and WATER PUMP SWITCH are in OFF position.

g. Make sure welding set is compatible with facility power (230 or 460 vac). Connect unit to facility power. Refer to paragraph 13-13 for wiring requirements. Connect ground strap to a facility ground.

h. Position controls as follows:

(1) ADJUSTABLE STARTING SPIKE to dial setting of 10 ±10% or as desired.

(2) ARC CONTROL to INERT ARC.

(3) CURRENT CONTROL as desired.

(4) PANEL REMOTE current switch (right-hand side) to REMOTE.

(5) PANEL REMOTE voltage switch (left-hand side) to PANEL.

(6) Polarity lever to STRAIGHT POLARITY.

(7) High-frequency unit ON-OFF switch to ON.

(8) AMMETER SELECTOR SWITCH as desired.

(9) MAIN CIRCUIT BREAKER to ON. Power on light on and cooling fan starts.

i. If cooling water is to be used, move WATER PUMP SWITCH to on.

j. Move AUTOMATIC MANUAL switch to MANUAL.

k. Adjust PRE FLOW timer to 2 to 10 seconds. Setting PRE FLOW timer provides a high-frequency spike and automatically sequences welding current with timer expiration. Failure to set PRE FLOW timer will result in a lack of high-frequency voltage, possibly resulting in operator grounding electrode in an attempt to establish a weld.

CAUTION

Grounding the electrode with the PRE FLOW timer set to one second or more can damage equipment.

l. Turn POST FLOW timer to setting desired.

13-19. PREPARING FOR AUTOMATIC TUNGSTEN INERT GAS WELDING.

13-20. Preparation for operation consists of connecting the welding set and the welding head together to perform melt-thru and lap-fillet in-place tube welding. A melt-thru weld is defined as a weld which melts through a sleeve, fitting, or adapter to provide a fillerless fusion to an enclosed tube. A lap-fillet weld is defined as a fillerless fusion of the end junction of a sleeve, fitting, or adapter to an encased tube.

a. Prepare welding set for use. (Refer to R-3825-3.)

b. Move the following switches and controls to specified positions:

(1) MAIN CIRCUIT BREAKER to OFF.

(2) WATER PUMP SWITCH to OFF.

(3) PANEL-REMOTE voltage switch to PANEL.

(4) WELD DURATION timer, FIXTURE DELAY timer, and SEQ. STOP timer switches to OFF.

(5) HI FREQUENCY, START-CONTINUOUS switch to OFF.

(6) Slope control panel START & TAIL ON-OFF switch to OFF.

c. Make sure MOTOR CONTROLLER AC switch is to OFF.

d. Connect electrical cables as shown in figure 13-2. Connect pneumatic purge supply hoses from gas bottles to supply ports on pressure control purge panel. Keep welding cables a minimum of 6 inches apart, except at welding unit and weld head, and isolate them from conductive surfaces either by suspending them, using a non-conductor, or laying them on a non-conductor. Insulate exposed current cable connecting couplings by wrapping with 29R plastic electrical tape (Permacel), or equivalent.

WARNING

The current cable connecting the weld head to the weld set power supply must not be grounded (short-circuited) as this can cause damage to equipment or injury to personnel.

CAUTION

Failure to isolate the welding cables can cause loss of high-frequency voltage resulting in failure to establish an arc.

e. Make sure gas cylinders have a sufficient supply of gaseous argon (MIL-A-18455), welding grade 99.8% pure, and helium that meets requirements specified in section I, to provide necessary shielding gas.

NOTE

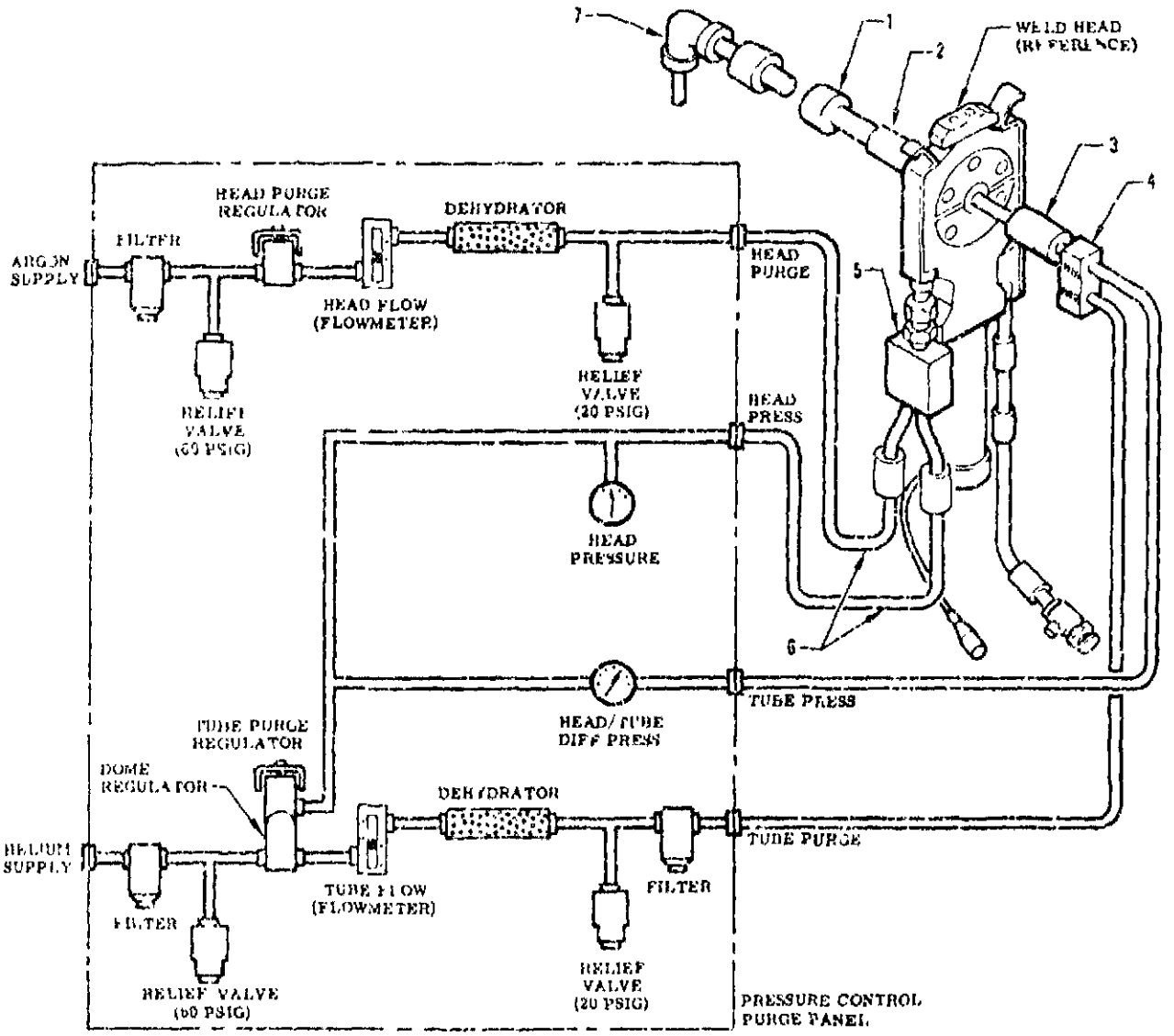
Argon must be used for the head purge. Argon or helium, may be used for the tube purge; however helium must be used when an engine weld or a sample weld prior to an engine weld is being performed for a J-2 engine.

f. Connect pressure control purge panel to welding head, as shown in figure 13-10A. Right-angle tube position tools 9027287 may be used in place of position tools 9027438 when welding in confined areas.

g. Connect ground strap to a facility ground.

h Make sure welding set is compatible with facility power (230 or 460 vac). Connect unit to facility power. Refer to paragraph 13-13 for wiring requirements.

Figures 13-9 and 13-10 deleted.



USE PARTS UNDER TUBE SIZE TO BE WELDED. WHERE DASH NUMBERS ARE NOT GIVEN, BASIC PART NUMBER IS USED FOR ALL TUBES.

INDEX NO.	NOMENCLATURE	BASIC PART NUMBER	DASH NUMBER REQUIRED FOR TUBE SIZE						
			1/4	5/16	3/8	1/2	5/8	3/4	1
1	CAP	1704	-5Y	-7Y	-9Y	-13Y	-17Y	-21Y	-27Y
2	TUBE POSITION TOOL	9027438		-11	-21	-31	-41	-51	-61
3	TUBE IN PLACE WELDING ADAPTER	9027217	-3	-5	-7	-9	-13	-15	-17
4	TUBE PURGE & PRESS HOSE	9027447-11							
5	HEAD PURGE ADAPTER	9027425							
6	HEAD PURGE & PRESS HOSE	9027448							
7	RIGHT-ANGLE POSITION TOOL	9027287							

32-5-1-11A

Figure 13-10A. Pressure Control Purge Panel Schematic and Use Setup

Figure 13-12 deleted.

13-21. IN-PLACE TUBE WELDING.

13-22. (Refer to R-3825-3.)

13-23. MAINTENANCE OF AUTOMATIC INERT GAS ARC WELDING SET.

13-24. Maintenance tasks required on the welding set are listed in figure 13-13. Information presented lists the tasks to be performed, when the tasks must be performed, and reference to data necessary to accomplish these tasks.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect welding set for completeness.	X				See figures 13-2 and 13-6.
Check operating voltage, continuity of power cable and voltage compensator, installation of power jumper links, clearance between high-frequency electrodes, and output of voltage compensator.	X			X	After repair. Refer to paragraph 13-13.
Inspect welding set for cleanness.	X			X	Clean as required. Refer to paragraphs 13-39.
Lubricate: Wheel bearings				X	Every six months. Refer to paragraph 13-41.

Figure 13-13. Maintenance Requirements (Sheet 1 of 3)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Tow bar, Pneumatic, inert gas electrical and water connections.				X	Each time connection is made. Refer to paragraph 13-41.
Calibrate	X			X	Whenever acceptable welds cannot be obtained within weld schedule parameters. Refer to weld schedule in R-3825-3.
Adjust: Speed controller				X	Prior to initial use and whenever instability of welding head speed control is encountered. Refer to paragraph 13-33.
High-frequency electrodes	X			X	After every 300 hours of operation. Refer to paragraph 13-31.
Inspect (visually) all exposed relay contacts for evidence of wear and damage.				X	Every six months. Refurbish or replace as required.
Inspect caster brakes for positive locking action.	X	X			Adjust brakes. Refer to paragraph 13-44.
Inspect caster swivel-lock pins for restricted movement.	X	X			Lubricate lock-pins. Refer to paragraph 13-41.
Inspect protective cover for torn or damaged surfaces.	X	X			
Inspect electrical cables for broken or frayed insulation and broken or damaged connectors.		X			Replace damaged cables.
Clean welding set electrical gage lens to remove accumulated static electricity.		X			Hand wipe gage lens with cloth moistened with a solution of 4-6 ounces of mild alkaline cleaner RB0210-002 or RB0210-005 (Rocketdyne), or equivalent,

Figure 13-13. Maintenance Requirements (Sheet 2 of 3)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
					heated to 140° to 160° F. Wipe dry with lint-free cloth.
Clean purge adapters, purge hoses, and tools.				X	Prior to use, whenever cleanness level does not meet inspection requirements of section I. Refer to Cleaning, section I.
Clean welding set cover.				X	Prior to use of cover. Refer to paragraph 13-45.
Coat zipper surfaces of welding set cover.				X	Every 3 months, after cleaning cover, or whenever zipper becomes difficult to operate. Spray zipper surfaces lightly with Mold Release 225 (Ram Chemicals).
Adjust slider for closing welding set cover zipper.				X	Whenever slider becomes difficult to operate or fails to close zipper. Adjust slider by turning both set screws 90° clockwise (if slider rolls too easily) or 90° counterclockwise (if slider is too tight). Repeat adjustment until slider operates smoothly.
Paint welding set.				X	When painted surfaces are exposed, paint exposed surfaces with orange yellow enamel (MIL-E-7729, Type I), color 13538 (Federal Standard 595).

Figure 13-13. Maintenance Requirements (Sheet 2A of 3)

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Stencil markings				X	When obliterated, stencil markings with black enamel (MIL-E-7729), color 27038 (Federal Standard 595).
Function-test automatic inert gas arc welding set.	X			X	After repair or replacement of components. Refer to paragraph 13-35.
Proof-test sling				X	Every 6 months. Proof-test sling by suspending 7,000 ±140 pounds from sling for a minimum of 3 minutes. See figure 13-13A for proof-test weight requirements.
Clean welder.				X	Refer to paragraph 13-39.
Proof-pressure-test gaseous argon regulator hose and purge supply hose.				X	Every 6 months. Refer to paragraph 13-46.
Connect purge hoses end to end.				X	To prevent contamination, whenever purge hoses are not in use.
Replace pressure control purge panel dehydrators.				X	Every 12 months. Remove and install new dehydrators. Lubricate threads (Method A, section I) with lubricant grease RB0140-012 (Rocketdyne). Torque fittings. Refer to section I.

Figure 13-13. Maintenance Requirements (Sheet 3 of 3)

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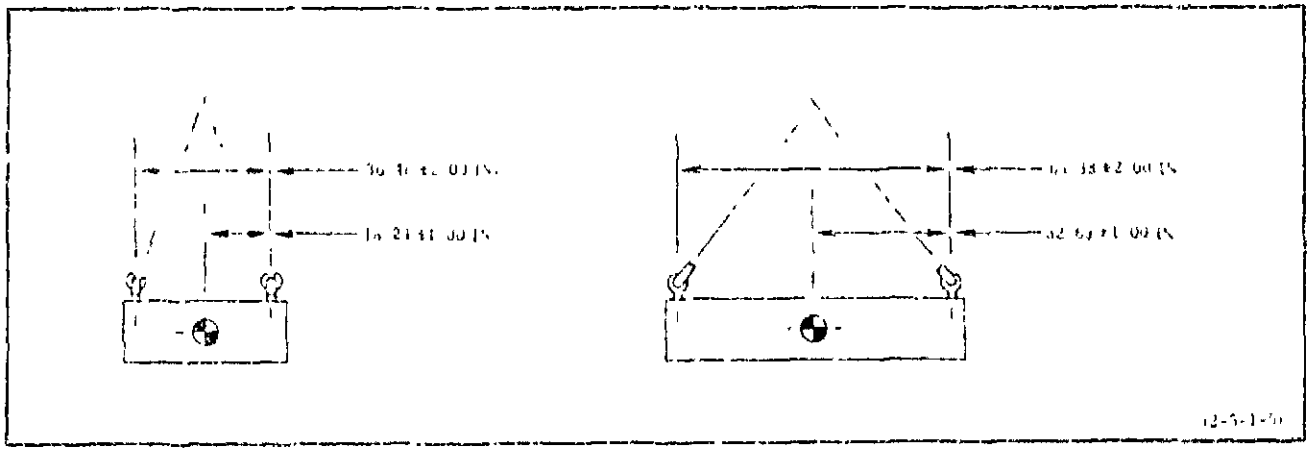


Figure 13-13A. Sling Proof-Test Weight Requirements

13-25. CALIBRATING.

13-26. CALIBRATING PRE FLOW, POST FLOW, FIXTURE DELAY, AND SEQ. STOP TIMERS. Timers must be calibrated within ± two percent of full scale. Use terminals 4 and 5 for calibration. See figure 13-14 for contact identification.

13-27. CALIBRATING WELD DURATION TIMER. The weld duration timer must be calibration-checked at ten-second, 60-second, three-minute, and five-minute durations to ensure an accuracy of ± five percent. See figure 13-14 for contact identification.

13-28. CALIBRATING VOLTMETER AND AMMETER. The voltmeter and ammeter must be calibration-checked to ensure an accuracy of two percent of full scale. The ammeter must be checked with its associated range multiplier resistors.

13-29. (Deleted)

13-30. CALIBRATING PRESSURE CONTROL PURGE PANEL. Calibrating the purge panel consists of calibrating the HEAD PRESSURE and the HEAD/TUBE DIFF PRESS gages. There is no requirement to calibrate the HEAD FLOW or TUBE FLOW flowmeters. These instruments are used for indicating only and are checked for minimum operating requirements during function-testing of the purge panel. See figure 13-13B for pressure gage calibration check requirements. The gages listed in figure 13-13B are used in pneumatic systems.

Part Number	Nomenclature	Range/Accuracy (± Full Scale)	Test Standard (a) Minimum Accuracy (± Full Scale)
2004	HEAD PRESSURE	0-4 inch-water (2%)	0.8%
2304	HEAD/TUBE DIFF PRESS	2-0-2 inch-water (2%)	0.8%

(a) Range of test standard must be at least 100% but not more than 125% of range of instrument being tested.

Figure 13-13B. Pressure Gage Calibration-Check Requirements

13-31. ADJUSTING HIGH-FREQUENCY ELECTRODES.

13-32. Remove cover from nigh-frequency unit and check spacing between high-frequency electrodes for 0.012-inch clearance. Reset spacing if necessary.

13-33. ADJUSTING SPEED CONTROLLER.

13-34. The following procedure adjusts the controller to either large or small weld heads: (For functional test, adjustment of speed controller must be accomplished in both positions using appropriate weld head and potentiometers.)

a. Assemble weld head for which controller is to be adjusted. Refer to section XIV for information on assembling weld head, but do not install upper side plates. Leaving upper side plates off permits visual observation of rotor, an aid in determining amount of rotor rotation.

b. Connect head assembly to controller.

c. Set the following switches on controller to positions noted:

(1) LARGE HEAD/SMALL HEAD on rear panel to position corresponding to connected weld head.

(2) AC to ON.

(3) DC to FWD or REV.

d. Set the following switches on welder to positions noted:

(1) PANEL REMOTE CURRENT to REMOTE.

(2) PANEL REMOTE VOLTAGE to PANEL.

(3) High frequency to OFF.

(4) WELD DURATION to ON.

(5) FIXTURE DELAY to ON.

(6) SEQ. STOP to ON.

(7) AUTOMATIC/MANUAL to AUTOMATIC.

e. Set POST FLOW and FIXTURE DELAY timers to 1-2 seconds.

f. Set PRE FLOW timer to zero second.

NOTE

Timer settings in steps g and h must be set as accurately as possible, since the combined time set on these timers determines the length of time the weld head motor operates.

g. Set SEQ. STOP timer to 5 seconds.

h. Set WELD DURATION timer to 55 seconds.

i. Connect remote control box to welder.

j. Connect welder to facility power.

NOTE

Potentiometers referred to in this procedure are on the rear panel of the motor controller and must be adjusted in the row associated with the connected weld head.

- Whenever this test requires adjusting a potentiometer, loosen locknut to make adjustment, then retighten sufficiently to prevent inadvertent movement of adjustment screw. Results must be obtained with locknut tightened.

k. Rotate potentiometer R4 fully clockwise.

l. Rotate potentiometer R6 fully counterclockwise.

m. Move MAIN CIRCUIT BREAKER to ON. Fan starts, light on controller comes on, and SPEED PERCENT meter may indicate a value. An indication on the SPEED PERCENT meter is not required.

n. Unlock SPEED CONTROL dial and rotate SPEED CONTROL until 1,000 is indicated on SPEED CONTROL dial.

o. Depress FIXTURE JOG button, note direction of rotation of weld head rotor, and release FIXTURE JOG button.

p. Move DC switch on MOTOR CONTROLLER to alternate position.

q. Depress FIXTURE JOG button, note direction of rotation of weld head rotor, and release FIXTURE JOG button. Rotor must rotate opposite the direction in step o.

r. Depress FIXTURE JOG button. Weld head motor operates. Keep FIXTURE JOG button depressed until electrode tip is at 3 or 9 o'clock, then release it.

s. Momentarily depress SEQ. START button and count revolutions of rotor. Rotor does not start until FIXTURE DELAY timer times out and continues until WELD DURATION and SEQ. STOP timers time out. Rotor must complete, within ±10 percent, 3 revolutions if large head is connected, and 4-1/2 if small head is

connected. If rotor speed requirement is not met, adjust potentiometer R5 and repeat steps r and s.

t. Adjust potentiometer R3 until SPEED PERCENT meter indicates 100 ±1.

u. Rotate SPEED CONTROL until SPEED CONTROL dial indicates 200.

v. Depress FIXTURE JOG button until electrode tip in weld head is at 3 or 9 o'clock, then release it.

w. Momentarily depress SEQ. START button and count revolutions of rotor. Rotor does not start until FIXTURE DELAY timer times out and continues until WELD DURATION and SEQ. STOP timers time out. Rotors must complete, within ±10 percent, one revolution if large head is connected, and 1-1/2 if small head is connected. If rotor speed requirement is not met, adjust potentiometer R6 and repeat steps v and w.

x. Adjust potentiometer R4 until SPEED PERCENT meter indicates 20 ±1.

y. Repeat steps n and r through x until maximum synchronization of SPEED PERCENT meter, SPEED CONTROL dial, and rotor speeds is obtained. Maximum synchronization is obtained when all requirements are met for one full cycle without potentiometer adjustment. A minimum of 3 cycles is usually required to obtain maximum synchronization.

z. (Deleted)

aa. Move MAIN CIRCUIT BREAKER to OFF. Fan stops, light on MOTOR CONTROLLER goes off, and SPEED PERCENT meter indicates zero.

ab. Disconnect and store head assembly.

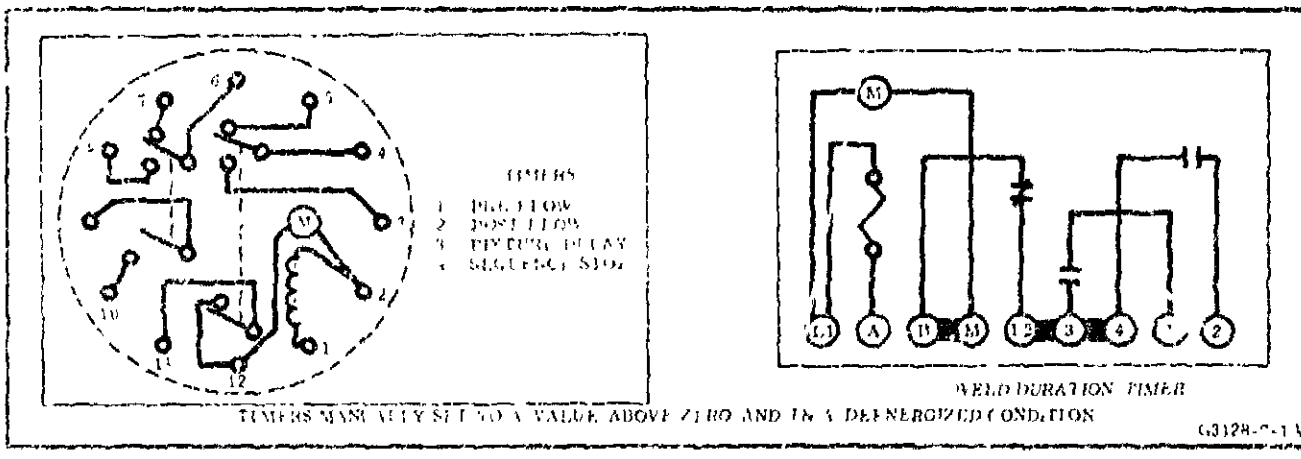


Figure 13-14. Timer Contacts Identification

13-35. FUNCTION-TESTING AUTOMATIC INERT GAS ARC WELDING SET.

13-36. Function-testing consists of connecting a welding head from Single Head Special Tool Kit G3127 to welding set, pre-setting the equipment to recommended values, and performing, then repeating, a weld on the smallest and largest tube and sleeve combination. A function-test (paragraph 13-37) of the pressure control purge panel is required prior to function-testing the welding set. To perform a function-test, weld a 1/4 x 0.028 tube and sleeve RD273-1023-0005, and a 3/4 x 0.049 tube and sleeve RD273-1023-5006, using procedure in R-3825-3. Test equipment and materials required to function-test welding set are as follows.

a. Single Head Special Tool Kit G3127.

b. Gaseous argon (MIL-A-18455), welding grade 99.8 percent pure.

c. Facility power input of 230 or 460 vac, 60 cycles, 3 phase.

d. Corrosion-resistant steel tubing RB0160-045 (Rocketdyne) or CRES tubing (MIL-T-8808), 1/4 x 0.028 and 3/4 x 0.049. (Minimum length is 2 inches longer than width of holding fixture.)

e. Sleeves RD273-1023-0005 and RD273-1023-5006.

13-37. FUNCTION-TESTING PRESSURE CONTROL PURGE PANEL.

13-38. Function-testing the purge panel consists of checking relief valve opening pressure, checking operation of the flowmeters, and leak-testing.

a. Remove back panel from purge panel.

b. Remove argon supply (60 psig) relief valve.

c. Connect a regulated source (70 psig minimum) of pressurized gaseous nitrogen (MIL-P-27401) to relief valve inlet.

d. Slowly increase supply pressure to relief valve until valve relieves. Relief valve must relieve between 54 and 66 psig.

e. Decrease supply pressure to zero.

f. Remove test equipment from relief valve, and install relief valve in purge panel. Refer to section I for lubrication requirements.

g. Remove helium supply (60 psig) relief valve and repeat steps c through f.

h. Remove head purge (20 psig) and tube purge (20 psig) relief valves from purge panel. Repeat steps c through f, except relief valves must relieve between 18 and 22 psig.

i. Remove pressure caps from HEAD PURGE and TUBE PURGE ports.

j. (Deleted)

k. Connect a regulated source (50 psig minimum) of pressurized gaseous nitrogen (MIL-P-27401) to ARGON SUPPLY and HELIUM SUPPLY ports.

l. Slowly apply 5-10 psig pressure to panel supply ports while observing HEAD FLOW and TUBE FLOW flowmeters. Do not permit flow to exceed range of flowmeters.

NOTE

In steps m through p, a zero flow indication is not required.

m. Slowly turn HEAD PURGE REGULATOR control knob to INCR until HEAD FLOW flowmeter ball indicates full flow. Slowly turn control knob to DECR. Flowmeter ball must rise and settle smoothly and respond immediately to regulator movement.

n. Repeat step m 2 times.

o. Slowly turn TUBE PURGE REGULATOR control knob to INCR until HEAD FLOW flowmeter ball indicates full flow. Slowly turn control knob to DECR. Flowmeter ball must rise and settle smoothly and respond immediately to regulator movement.

p. Repeat step o 2 times.

q. Connect a hose and vent valve from TUBE PURGE port to TUBE PRESSURE port. Close vent valve.

r. Connect a hose and vent valve from HEAD PURGE port to HEAD PRESSURE port. Close vent valve.

s. Slowly increase supply pressure to 50 ±5 psig.

t. Slowly turn HEAD PURGE REGULATOR to full INCR. HEAD PRESSURE; HEAD/TUBE DIFF PRESS gages will peg, but this is not detrimental to gages.

u. While monitoring HEAD/TUBE DIFF PRESS gage, carefully turn TUBE PURGE REGULATOR to INCR until HEAD/TUBE DIFF PRESS gage indicator leaves pegged condition. Then manipulate regulator, as necessary, to cause indicator to stabilize in the operating range of HEAD/TUBE DIFF PRESS gage.

v. Using leak-test compound (MSFC-SPEC-384), leak-test all interconnecting tubing fittings for zero leakage.

NOTE

Zero leakage is defined as no visible growth in bubble size in one minute.

w. Slowly move HEAD PURGE REGULATOR and TUBE PURGE REGULATOR to decrease pressure to zero. HEAD PRESSURE; HEAD/TUBE DIFF PRESS gages may peg, but this is not detrimental to gages.

x. Decrease supply pressure to panel to zero.

y. Open vent valves in interconnecting lines between HEAD PURGE and HEAD PRESS and TUBE PURGE and TUBE PRESS.

z. Disconnect interconnecting hoses, vent valves, and supply source. Install pressure caps on purge panel ports.

aa. Install panel back.

13-39. CLEANING.

13-40. Interior and exterior surfaces of the automatic inert gas arc welding set and accessories must be kept free of dust, dirt, grease, and all foreign particles. Frequency of inspection and cleaning operation depends on the environment in which welder is being used. Refer to Cleaning, section I.

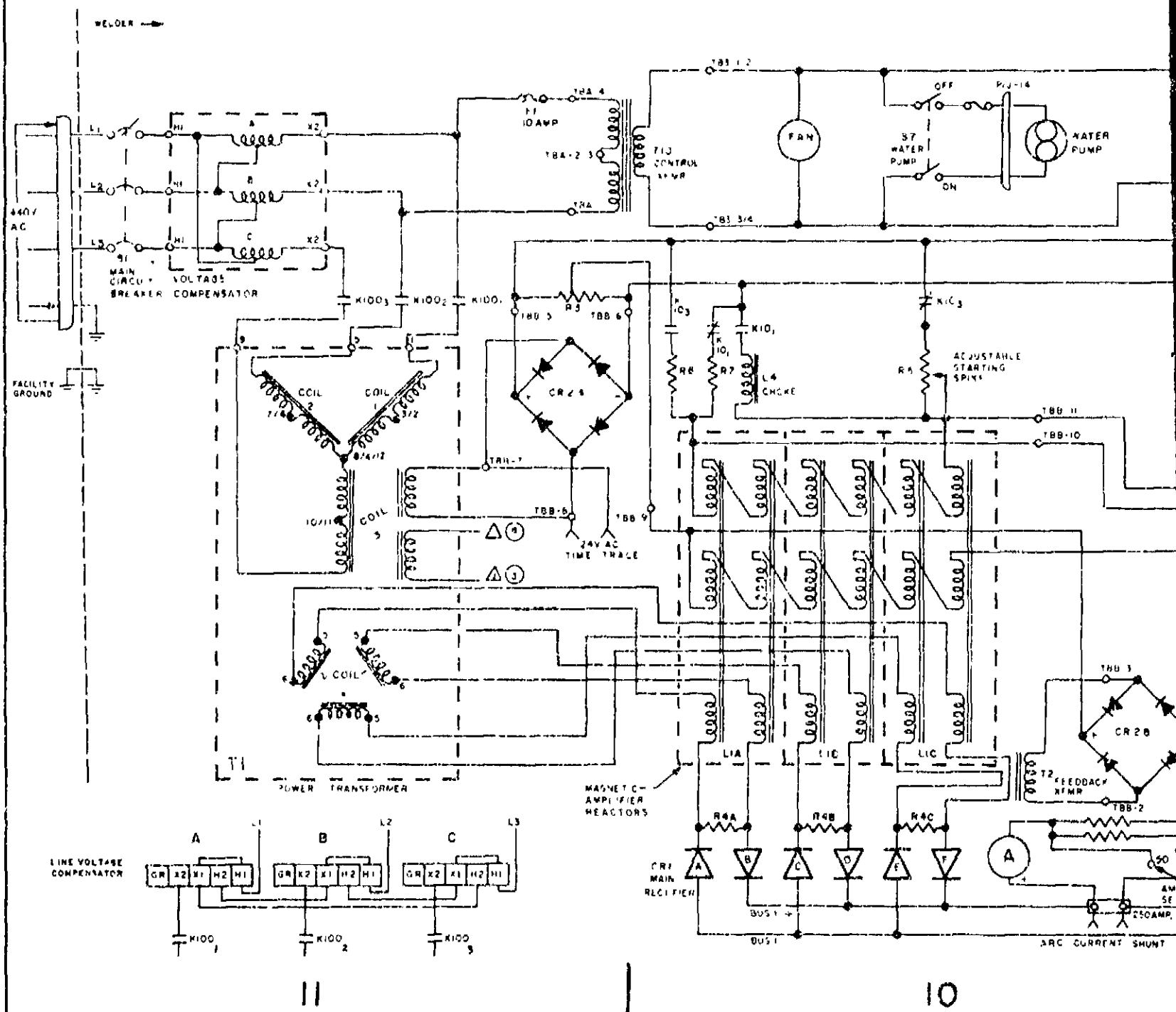
13-41. LUBRICATING.

13-42. Lubricate welding set components and accessories as follows:

NOTE

Wheel bearings do not require servicing as they are permanently lubricated.

a. (Deleted)


WELDER
440V AC
FACILITY GROUND
MAIN CIRCUIT BREAKER
VOLTAGE COMPENSATOR
K100 3
K100 2
K100 1
T1
POWER TRANSFORMER
COIL 1
COIL 2
COIL 3
COIL 4
TB4-4
T1 10AMP
TB4-2 3
TB4-1
T13 CONTROL XFMR
TB3 1 2
TB3 3/4
FAN
OFF
P/O-14
S7 WATER PUMP
ON
WATER PUMP
TB8 5
TB8 6
R3
CR2 8
TB8-7
TB8-6
TB8 9
24V AC TIME TRACE
R8
R7
K10 1
K10 3
L4 CHOKE
R5
ADJUSTABLE STARTING SPIKE
TB8 11
TB8-10
L1A
L1B
L1C
MAGNETIC AMPLIFIER REACTORS
CR1 MAIN RECTIFIER
R4A
R4B
R4C
BUS1 +
BUS1 -
CR2B
T2 FEEDBACK XFMR
TB8 3
TB8-2
A
50
250AMP.
ARC CURRENT SHUNT
LINE VOLTAGE COMPENSATOR
A
B
C
L1
L2
L3
GR
X2
X1
H2
H1
K100 1
K100 2
K100 3

11 | 10

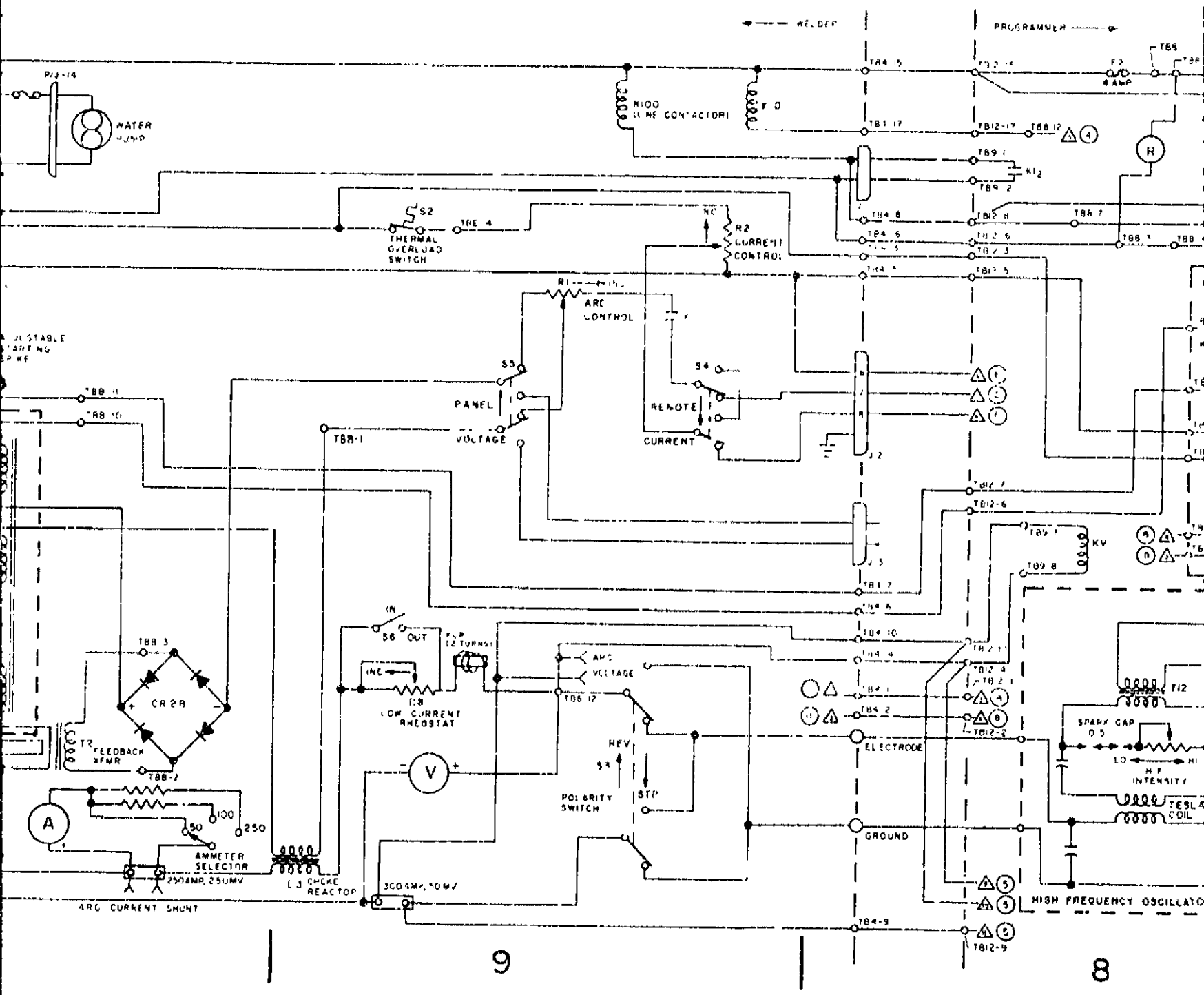


Figure 13-15. Elect

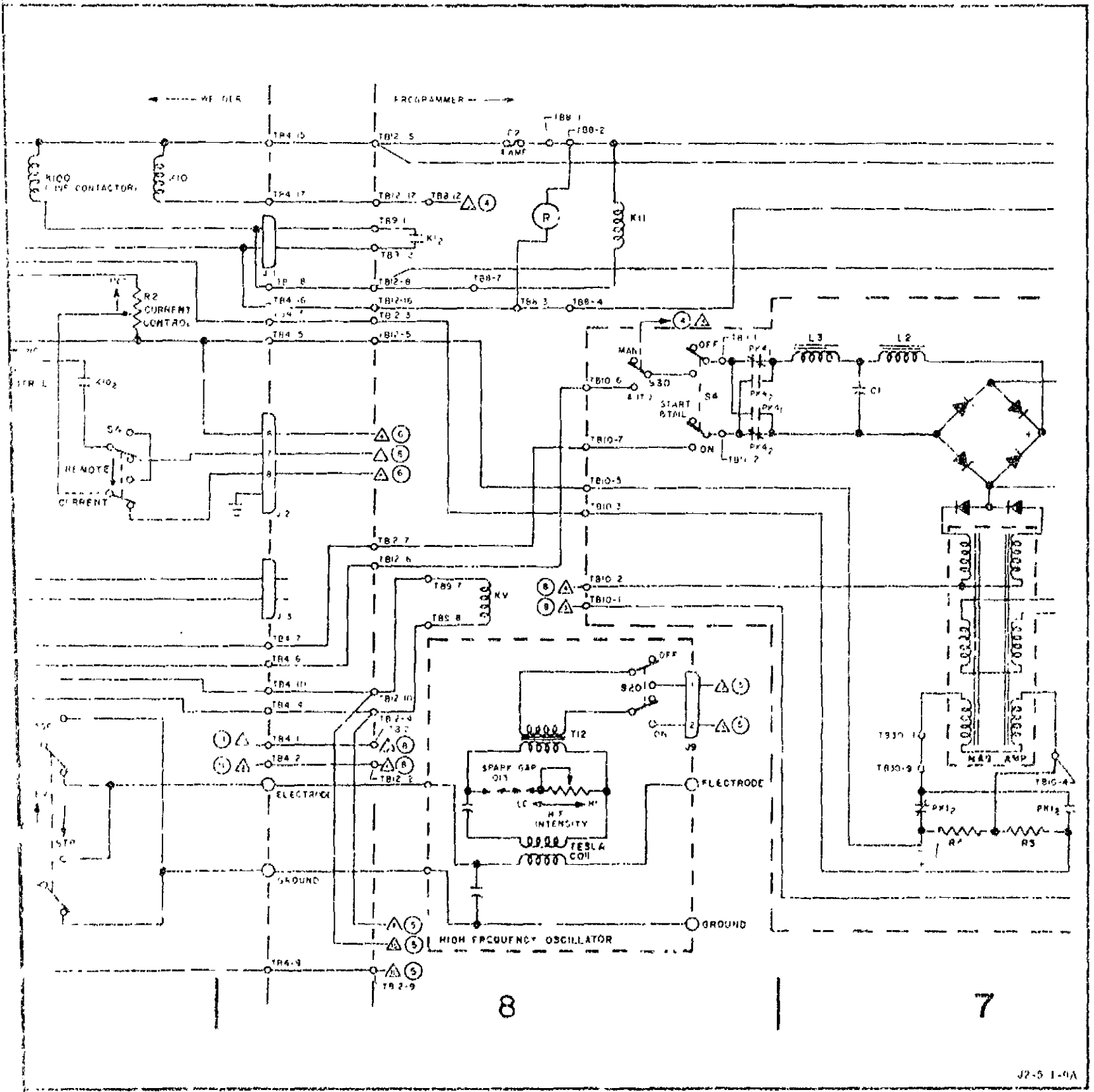
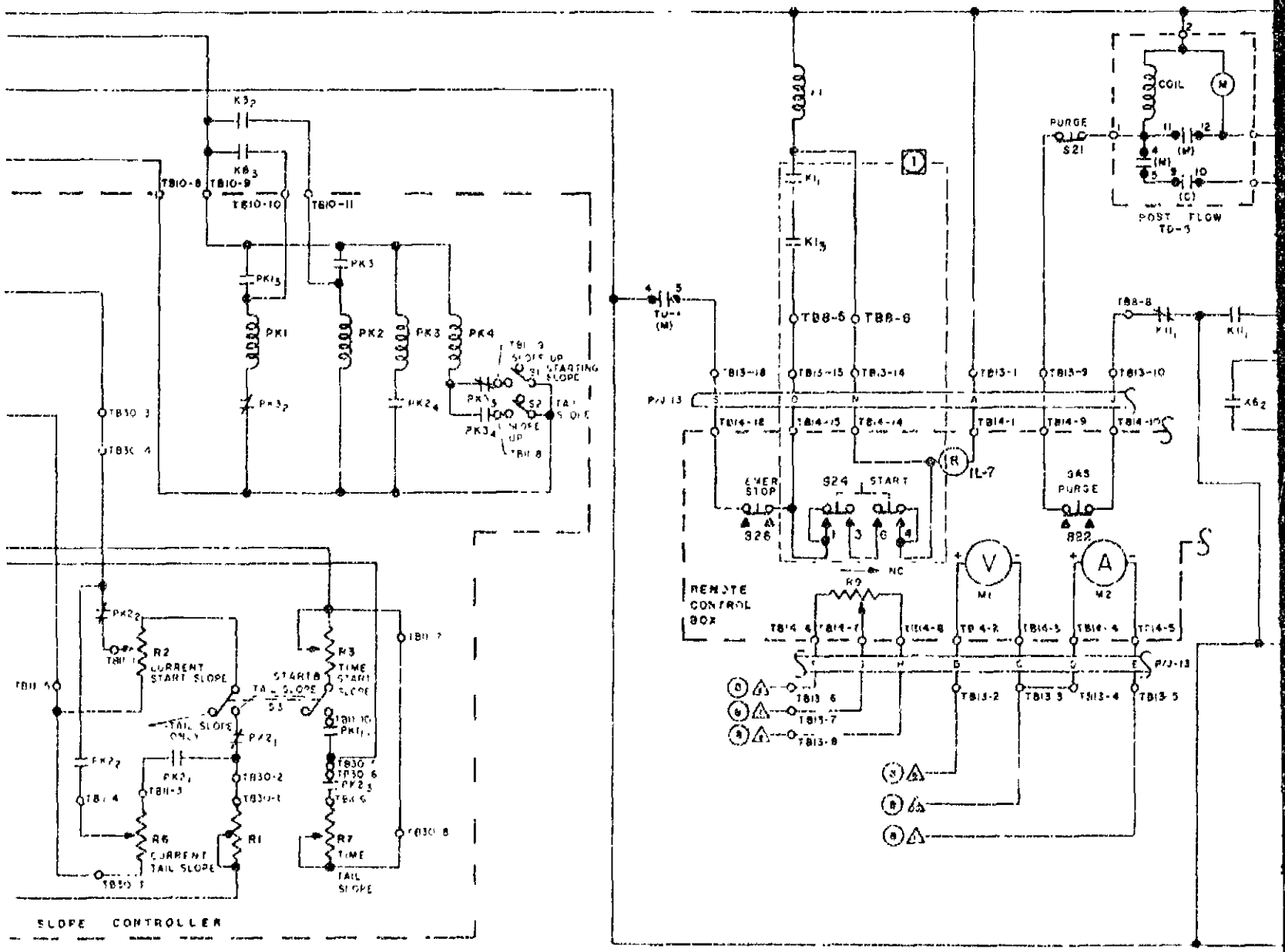
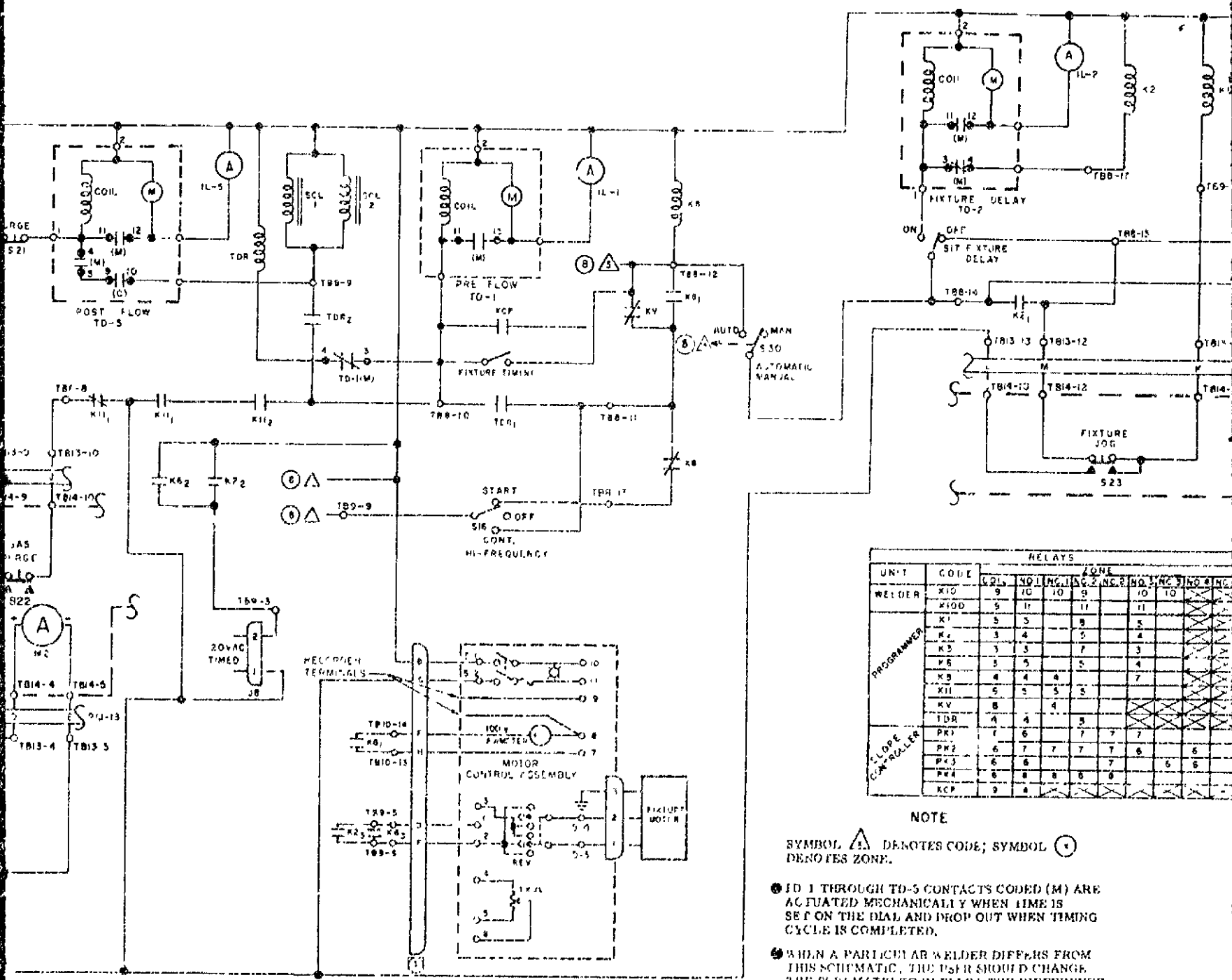


Figure 13-15. Electrical Schematic (Sheet 1 of 3)



1 ON UNITS INCORPORATING MDS CHANGE (SEE SHEET 3 FOR UNITS NOT INCORPORATING MDS CHANGE)

7 | 6 | 5



UNIT	CODE	RELAYS ZONE CR1	NO 1	NC 1	NC 2	NC 2	NO 3	NC 3	NO 4	NC
WELDER	K10	9	10	10	9		10	10		
	K10D	5	11		11		11			
PROGRAMMER	K1	5	5		8		5			
	K2	3	4		5		4			
	K3	3	3		7		3			
	K5	5	5		5		4			
	K6	4	4	4			7			
	K9	5	5	5	5					
	K11	8		4						
	KV	4	4		5					
	TDR	4								
SLOPE CONTROLLER	PR1	6	6		7	7	7			
	PR2	6	7	7	7	7	6		6	
	PR3	6	6		7			6	6	
	PR4	6	8	8	6	6				
	KCP	9	4							

NOTE

SYMBOL △ DENOTES CODE; SYMBOL ⑥ DENOTES ZONE.

● TD 1 THROUGH TD-5 CONTACTS CODED (M) ARE ACTUATED MECHANICALLY WHEN TIME IS SET ON THE DIAL AND DROP OUT WHEN TIMING CYCLE IS COMPLETED.

● WHEN A PARTICULAR WELDER DIFFERS FROM THIS SCHEMATIC, THE USER SHOULD CHANGE THE SCHEMATIC TO REFLECT THE DIFFERENCE, IDENTIFY THE SCHEMATIC WITH THE WELDER SERIAL NUMBER, AND FORWARD A COPY TO LOGISTICS PRODUCT SUPPORT DEPARTMENT.

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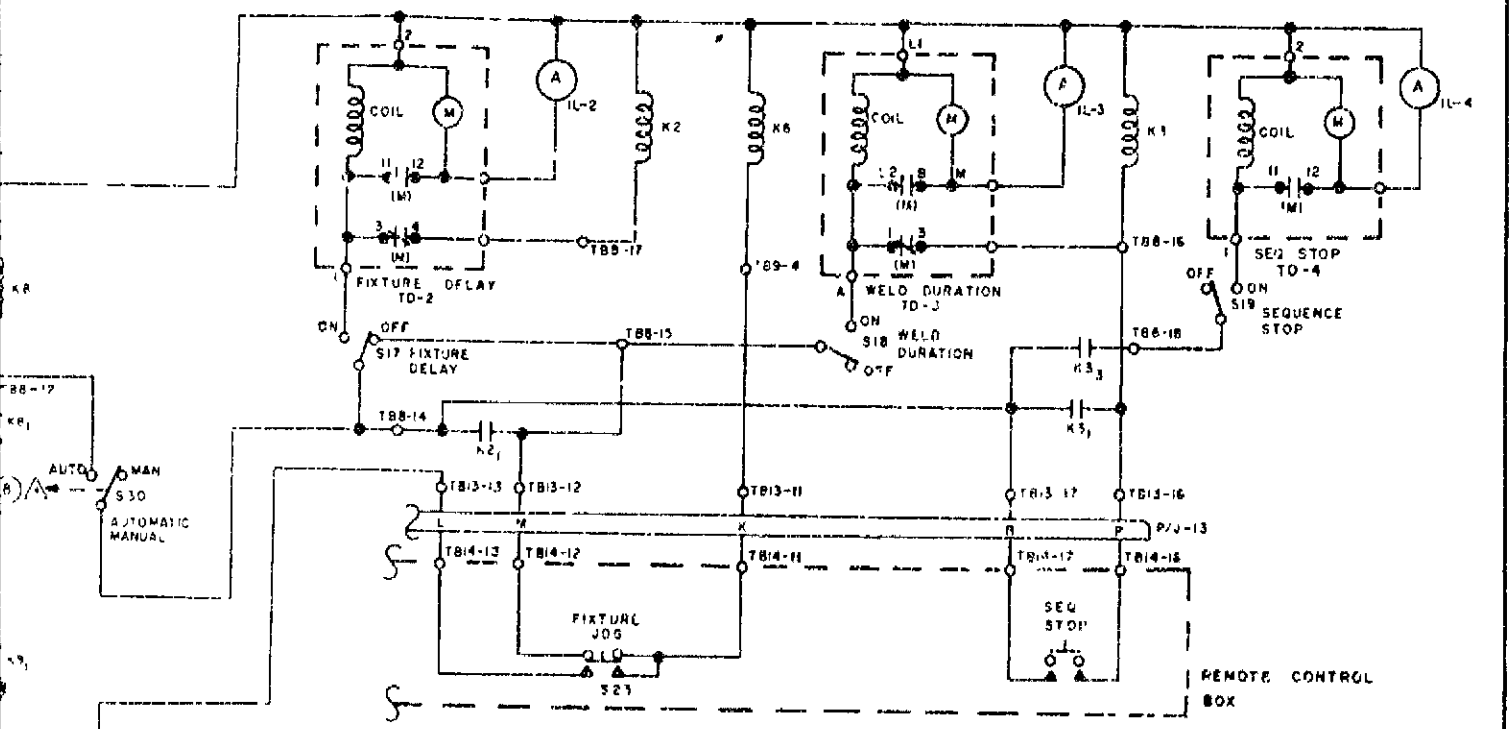
Figure 13-15. Ele



UNIT	CODE	RELAYS ZONE COIL	NO 1	NC 1	NO 2	NC 2	NO 3	NC 3	NO 4	NC 4
WELDER	K10	9	10	10	9		10	10		
	K10D	9	11		11		11			
PROGRAMMER	K1	5	5		6		5			
	K2	3	4		5		4			
	K3	3	5		7		5			
	K6	3	5		5		4			
	K8	4	4	4			7			
	K11	8	5	5	5					
	KV	8		4						
	TDR	4	4		5					
SLOPE CONTROLLER	PK1	6	6		7	7	7			
	PK2	6	7	7	7	7	6		6	
	PK3	6	6			7		6	6	
	PK4	6	8	8	8	8				
	K*P	0	4							

CODE	TIMERS ZONE METER AND COIL	METER CONTACTS NC	METER CONTACTS NO	COIL CONTACTS NC	COIL CONTACTS NO	COIL CONTACTS NC	COIL CONTACTS NO	METER CONTACTS NC	METER CONTACTS NO
	1 2	3 4	4 5	7 6	6 8	8 9	10	11	12
TD-1	4	5							4
TD-2	4	5							4
TD-4	2		6						2
TD-5	5		5				5		5
	COIL	MOTOR	NO	NC	NO				
	A 11	M	B	1	2				
TD-3	3	5	5	3					

NOTE

SYMBOL (1) DENOTES CODE; SYMBOL (X) DENOTES ZONE.

● TD-1 THROUGH TD-5 CONTACTS CODED (M) ARE ACTUATED MECHANICALLY WHEN TIME IS SET ON THE DIAL AND DROP OUT WHEN TIMING CYCLE IS COMPLETED.

● WHEN A PARTICULAR WELDER DIFFERS FROM THIS SCHEMATIC, THE USER SHOULD CHANGE THE SCHEMATIC TO REFLECT THE DIFFERENCE, IDENTIFY THE SCHEMATIC WITH THE WELDER SERIAL NUMBER, AND FORWARD A COPY TO LOGISTICS PRODUCT SUPPORT DEPARTMENT.

4 | 3 |

12-5-1-10B

Figure 13-15. Electrical Schematic (Sheet 2 of 3)

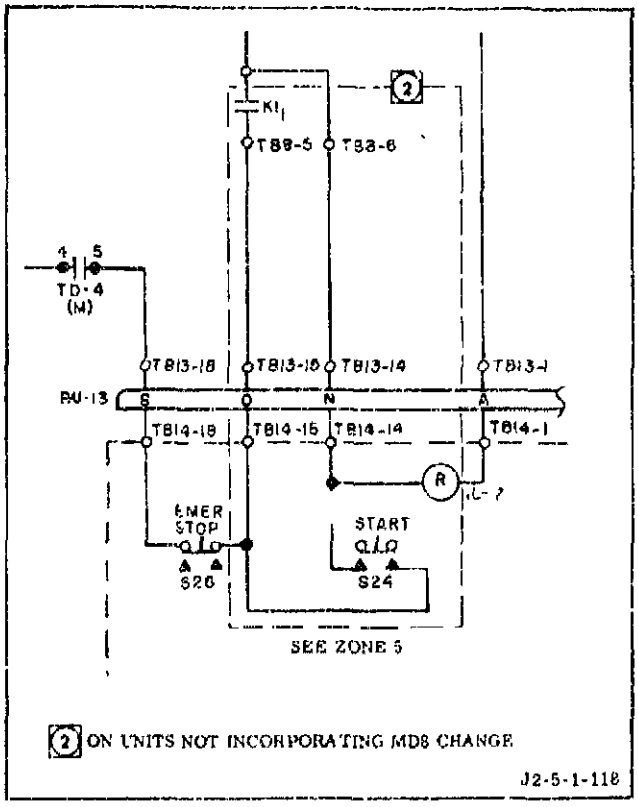


Figure 13-15. Electrical Schematic
(Sheet 3 of 3)

b. Lubricate threads on electrical connectors (Method A, section I) and threads and coupling nuts on pneumatic inert gas and water connectors (Methods A and G, section J) with FS1281 compound (Dow Corning Corp). Remove excess grease with a clean lint-free cloth.

c. (Deleted)

d. Lubricate caster swivel lock pins and brake lever actuators with lubricating oil (Federal Specification VV-L-800), or equivalent. Remove excess lubricant with clean, lint-free cloth.

13-43. MAINTENANCE OF AUTOMATIC INERT GAS ARC WELDING SET COMPONENTS.

13-44. ADJUSTING BRAKES. Adjusting caster brakes consists of positioning each brake to apply the required force to its caster wheel without overloading the brake lever.

a. Loosen bolt attaching brake to mounting bracket.

b. Actuate brake lever until nearly over center and hold. Position brake in serrations which allows brake shoe to touch wheel. Release brake lever.

c. Move brake one serration away from caster wheel and torque bolts. Refer to Torque Values for Threaded Fasteners, section I.

13-45. CLEANING COVER. Thoroughly clean covers as follows:

a. Hand wipe with a cloth moistened with a solution of 4-6 ounces of mild alkaline cleaner RB0210-002 or RB0210-005 (Rocketdyne), or equivalent, for each gallon of water heated to 140° to 160° F.

b. Rinse with clear water (130° to 150° F).

c. Wipe with clean, lint-free cloth and allow to dry thoroughly.

13-46. PROOF-PRESSURE-TESTING HOSES. Proof-pressure-test hoses with gaseous nitrogen. Pressurize hose for 2 minutes, vent pressure, and repeat cycle 4 times. No damage or permanent deformation is allowable. Leakage is allowable if operating pressures can be maintained during use. Pressurize hoses to the following pressures:

a. (Deleted)

b. Purge supply hose 9027422 to 75 ±2 psig.

c. Supply and vent hose 9027450 to 75 ±2 psig.

WARNING

Safety regulations must be observed when proof-pressure-testing. Proof pressure can burst a defective hose, causing injury or death.

SECTION XIV

SINGLE HEAD SPECIAL TOOL KIT G3127

WARNING

SINGLE HEAD SPECIAL TOOL KIT G3127 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

TABLE OF CONTENTS

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14-3	Theory of Operation	14-1
14-5	Configuration Changes--Manual Effectivity	14-1
14-7	MAINTENANCE OF SINGLE-HEAD SPECIAL TOOLKIT	14-10
14-9	REPAIR OF SINGLE-HEAD SPECIAL TOOLKIT COMPONENTS	14-10
14-11	Repairing Head Assemblies	14-10
14-13	Repairing Tube Cutter Assemblies	14-11

Underlined titles denote primary paragraphs.

14-1. DESCRIPTION AND LEADING PARTICULARS FOR SINGLE-HEAD SPECIAL TOOLKIT.

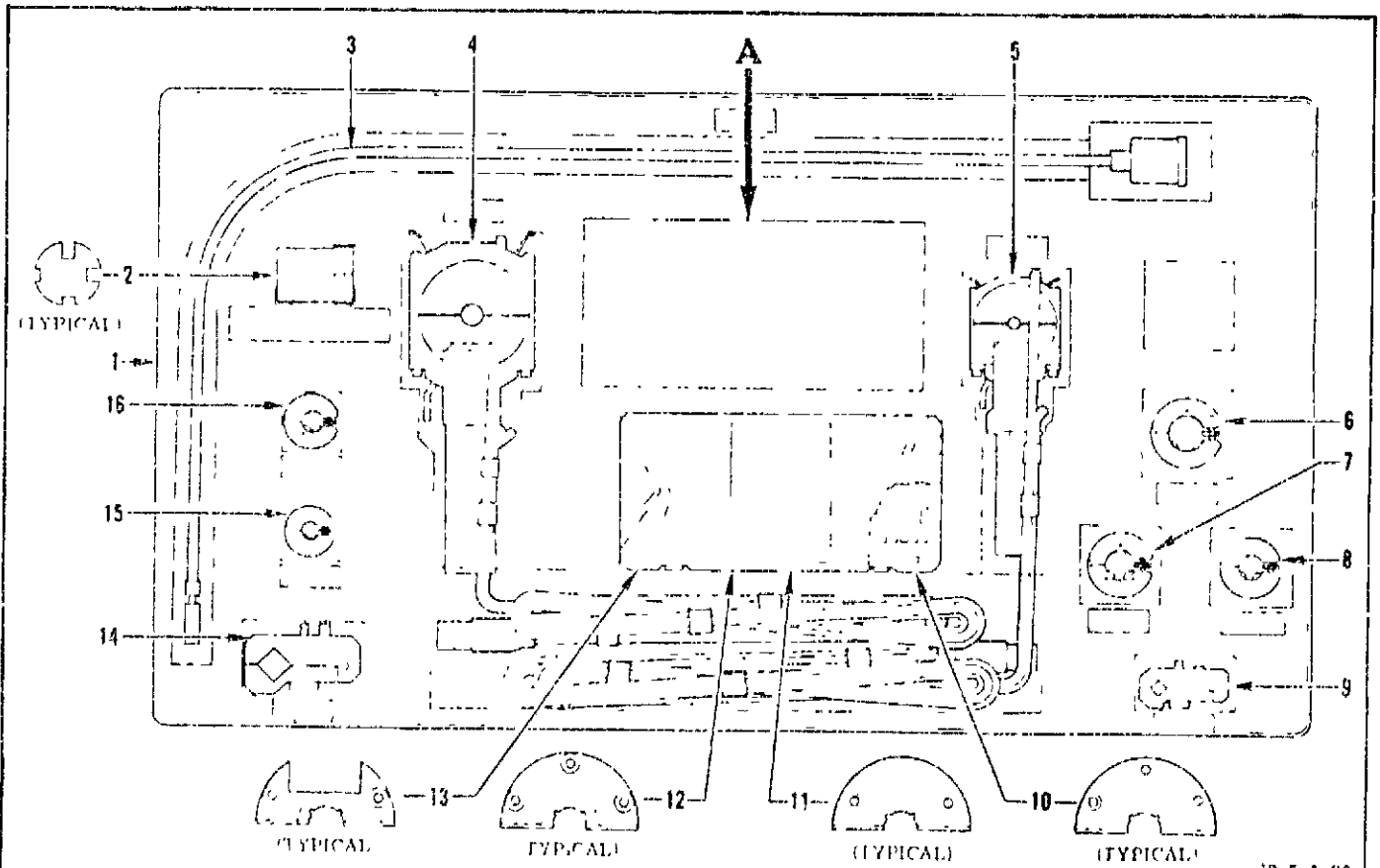
14-2. The single-head special toolkit (figures 14-1 and 14-2) provides the capability of cutting engine tubes and, used with Automatic Inert Gas Arc Welding Set G3128 (section XIII), the capability of welding tubes in place on the engine. Two weld heads, plus an assortment of weld head covers, electrodes, tube cutters, and gages, enable the cutting of 1/4 to 3/4 inch engine tubes and the welding of 1/4 to one inch engine tubes. Accessories include a flexible shaft that permits use of the large weld head in congested areas, and clamps to hold the weld head when the tube being welded is other than horizontal. Leading particulars for the toolkit are listed in figure 14-3, and instructions for use of the toolkit are in R-3825-3.

14-3. THEORY OF OPERATION.

14-4. Cutting of tubes is accomplished in the conventional manner of rotating a cutting wheel around the tube while incrementally diminishing the operating diameter of the cutter until the tube is caused to part. Tube cutters supplied in the single-head toolkit produce a chipless cut. The prime reason why chipless cuts are obtained is the design of the cutter wheel, which causes pressure to be applied to each side of the cut causing the tube to break under tension rather than being cut through. Welding is accomplished by rotating a rotor containing an electrode around the tube being welded. Specially designed weld heads retain the rotor centered around the tube. Through a geared pinion driven by a variable-speed motor, the rotor is caused to rotate around the tube. Welding current applied to the rotor through brush contacts produces a continuous, circumferential, melt-thru welded joint on the stationary, in-place engine tube. Welds with minimum external contamination are obtained by an inert gas purge supplied through a line connected to each head assembly, routed internally to envelop the weld area and then vented through relief ports provided in the covers.

14-5. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

14-6. The modifications incorporated in this manual that change the configuration of the single-head special toolkit are listed in figure 14-4.

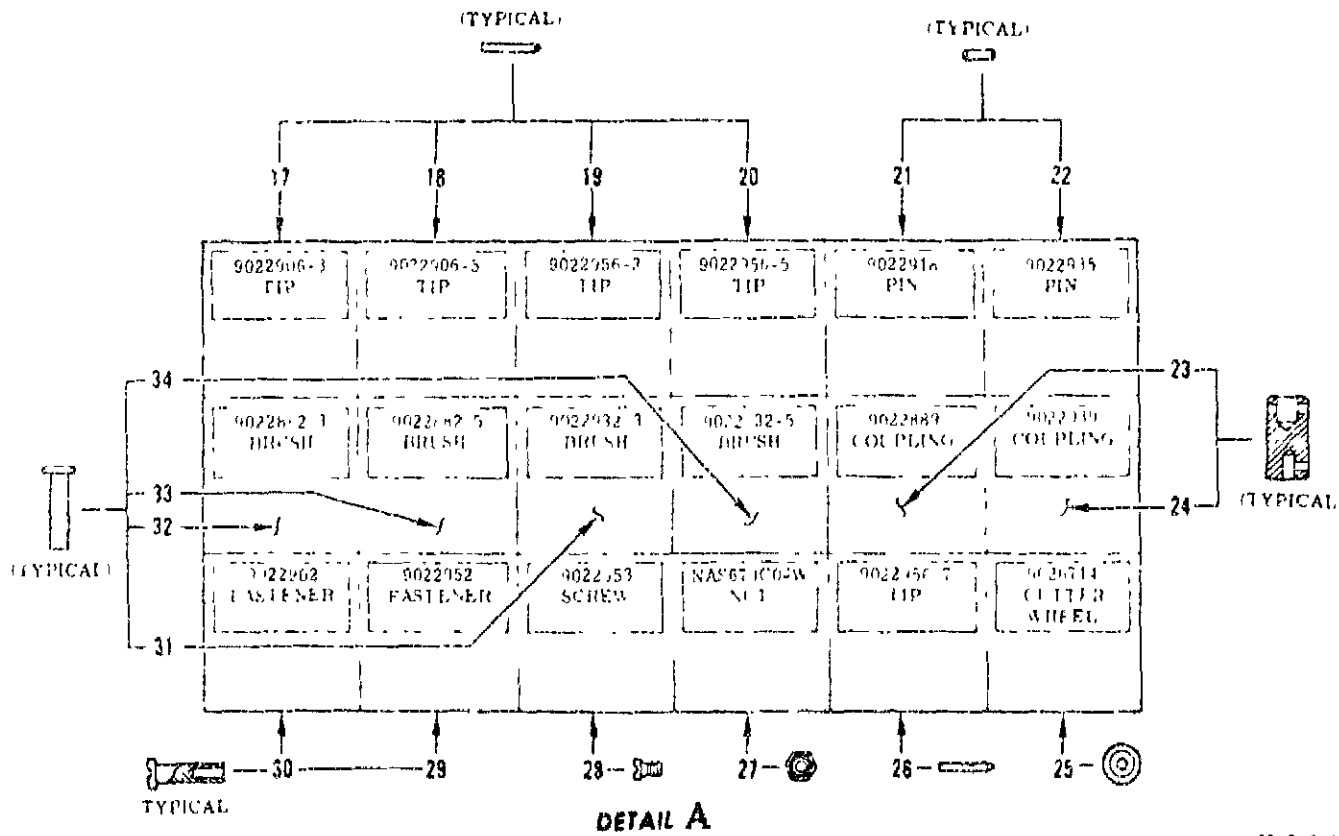


INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
	G3127	SPECIAL TOOL KIT, Single head	
1	9022967-11	. CONTAINER ASSY	1
2	9022917-3	. GAGE, Adjustment, electrode	1
2	9022917-5	. GAGE, Adjustment, electrode	1
2	9022917-7	. GAGE, Adjustment, electrode	1
2	9022917-9	. GAGE, Adjustment, electrode	1
2	9022960-3	. GAGE, Adjustment, electrode	1
2	9022960-5	. GAGE, Adjustment, electrode	1
2	9022960-7	. GAGE, Adjustment, electrode	1
2	9022960-9	. GAGE, Adjustment, electrode	1
3	9022910	. SHAFT ASSY, Flexible, 1/4 tubing, special tool . .	1
4	9022926-11	. HEAD ASSY, 5/8 THRU 1.00, special tool	1
5	9022876-11	. HEAD ASSY, 1/4 THRU 1/2, special tool	1
6	9026708	. CUTTER ASSY, Tube, 3/4 IN. (Alternate . . . . . CTC-AL-106, Precision Machine Specialties)	1
7	9026707	. CUTTER ASSY, Tube, 5/8 IN. (Alternate . . . . . CTC-AL-105, Precision Machine Specialties)	1
8	9026706	. CUTTER ASSY, Tube, 1/2 IN. (Alternate . . . . . CTC-AL-104, Precision Machine Specialties)	1
9	9022887	. CLAMP ASSY, Support, special tool	1
10	9022908-9	. COVER, Special tool, top, inner	2
10	9022908-13	. COVER, Special tool, top, inner	2
10	9022908-15	. COVER, Special tool, top, inner	2

Figure 14-1. Single-Head Special Toolkit (Not Incorporating MD2 Change) (Sheet 1 of 3)

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
10	9022908-35	. COVER, Special tool, top, inner	1
10	9022908-45	. COVER, Special tool, top, inner	1
10	9022908-47	. COVER, Special tool, top, inner	2
10	9022908-49	. COVER, Special tool, top, inner	2
10	9022908-53	. COVER, Special tool, top, inner	1
10	9022908-65	. COVER, Special tool, top, inner	1
10	9022958-13	. COVER, Special tool, top, inner	1
10	9022958-33	. COVER, Special tool, top, inner	1
10	9022958-37	. COVER, Special tool, top, inner	1
10	9022958-59	. COVER, Special tool, top, inner	1
11	9022909-9	. COVER, Special tool, bottom, inner	2
11	9022909-13	. COVER, Special tool, bottom, inner	2
11	9022909-15	. COVER, Special tool, bottom, inner	2
11	9022909-35	. COVER, Special tool, bottom, inner	1
11	9022909-45	. COVER, Special tool, bottom, inner	1
11	9022909-47	. COVER, Special tool, bottom, inner	2
11	9022909-49	. COVER, Special tool, bottom, inner	2
11	9022909-53	. COVER, Special tool, bottom, inner	1
11	9022909-65	. COVER, Special tool, bottom, inner	1
11	9022959-13	. COVER, Special tool, bottom, inner	1
11	9022959-33	. COVER, Special tool, bottom, inner	1
11	9022959-37	. COVER, Special tool, bottom, inner	1
11	9022959-59	. COVER, Special tool, bottom, inner	1
12	9022919-9	. COVER, Special tool, top, outer	2
12	9022919-13	. COVER, Special tool, top, outer	2
12	9022919-15	. COVER, Special tool, top, outer	2
12	9022919-35	. COVER, Special tool, top, outer	1
12	9022919-45	. COVER, Special tool, top, outer	1
12	9022919-47	. COVER, Special tool, top, outer	2
12	9022919-49	. COVER, Special tool, top, outer	2
12	9022919-53	. COVER, Special tool, top, outer	1
12	9022919-65	. COVER, Special tool, top, outer	1
12	9022961-13	. COVER, Special tool, top, outer	1
12	9022961-33	. COVER, Special tool, top, outer	1
12	9022961-37	. COVER, Special tool, top, outer	1
12	9022961-59	. COVER, Special tool, top, outer	1
13	9022920-9	. COVER, Special tool, bottom, outer	2
13	9022920-13	. COVER, Special tool, bottom, outer	2
13	9022920-15	. COVER, Special tool, bottom, outer	2
13	9022920-35	. COVER, Special tool, bottom, outer	1
13	9022920-45	. COVER, Special tool, bottom, outer	1
13	9022920-47	. COVER, Special tool, bottom, outer	2
13	9022920-49	. COVER, Special tool, bottom, outer	2
13	9022920-53	. COVER, Special tool, bottom, outer	1
13	9022920-65	. COVER, Special tool, bottom, outer	1
13	9022962-13	. COVER, Special tool, bottom, outer	1
13	9022962-33	. COVER, Special tool, bottom, outer	1
13	9022962-37	. COVER, Special tool, bottom, outer	1
13	9022962-59	. COVER, Special tool, bottom, outer	1
14	9022929	. CLAMP ASSY, Support, special tool	1
15	9026704	. CUTTER ASSY, Tube, 1/4 IN. (Alternate CTC-AL-102, Precision Machine Specialties)	1
16	9026705	. CUTTER ASSY, Tube, 3/8 IN. (Alternate CTC-AL-103, Precision Machine Specialties)	1

Figure 14-1. Single-Head Special Toolkit (Not Incorporating MD2 Change) (Sheet 2 of 3)

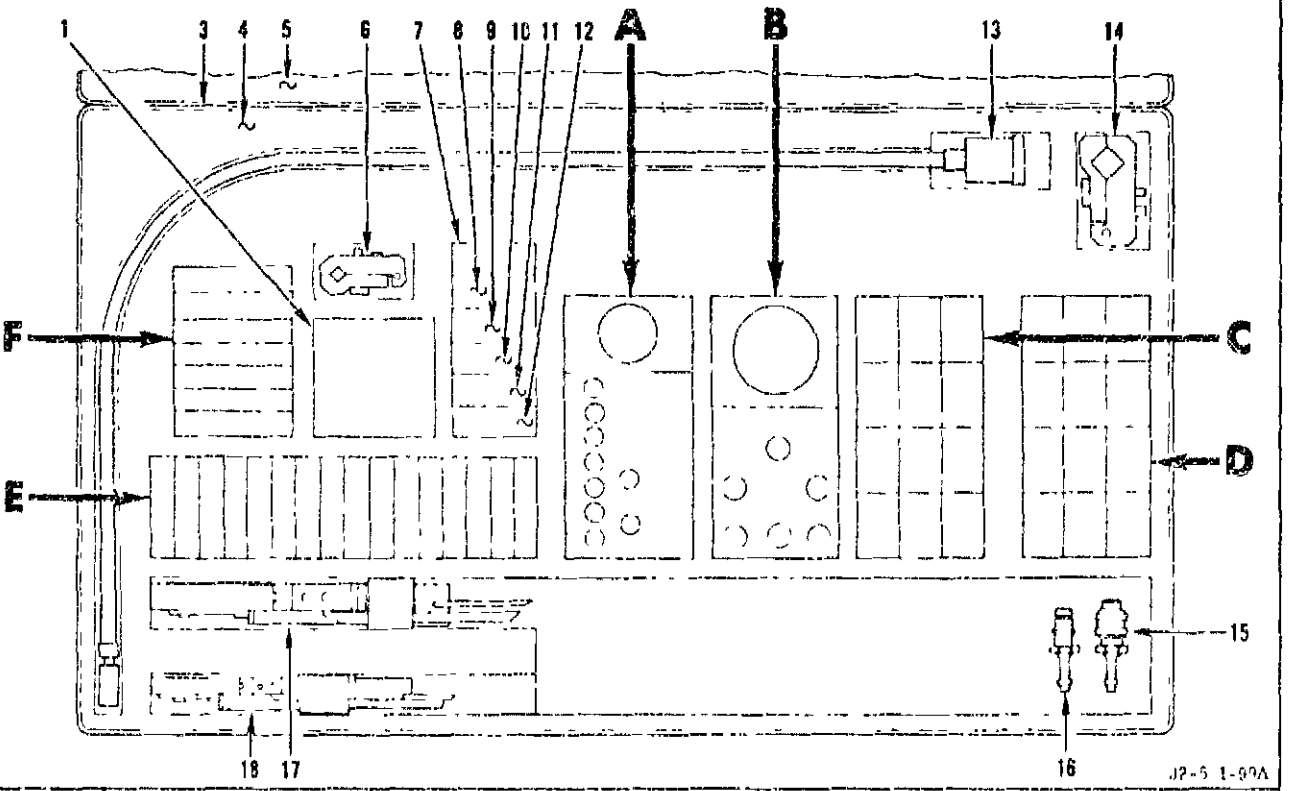


DETAIL A

J2-5-1-97

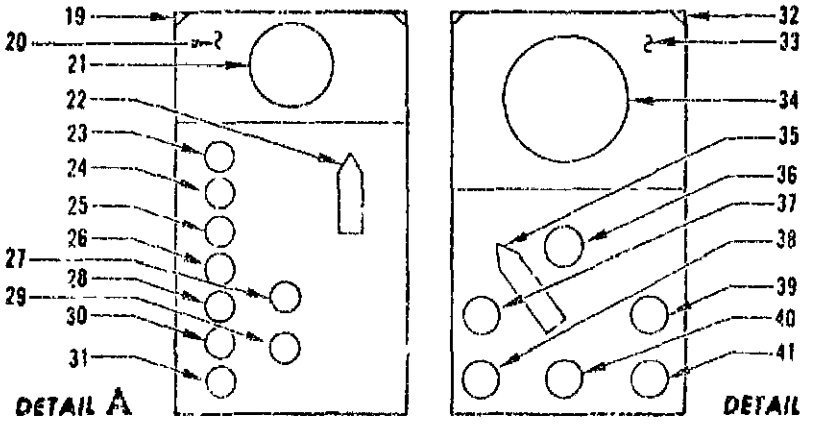
INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
17	9022906-3	. ELECTRODE. Special tool, 0.040 IN. DIA x 0.368 IN. (Alternate MRP-63-06-79)	12
18	9022906-5	. ELECTRODE, Special tool, 0.040 IN. DIA x 0.460 IN. (Alternate MRP-63-06-79)	12
19	9022956-3	. ELECTRODE, Special tool, 0.062 IN. DIA x 0.456 IN. (Alternate MRP-63-06-70)	12
20	9022956-5	. ELECTRODE, Special tool, 0.062 IN. DIA x 0.592 IN. (Alternate MRP-63-06-70)	12
21	9022918	. PIN, Special tool (0.093 IN. DIA x 0.375 IN.)	2
22	9022935	. PIN, Special tool (0.093 IN. DIA x 0.450 IN.)	2
23	9022889	. COUPLING ASSY, Motor, special tool, 0.395 IN. OD	1
24	9022939	. COUPLING, Special tool, 0.459 IN. OD	1
25	9026714	. CUTTER, Wheel, tube cutter, 1/4 THRU 3/4 (Alternate CWI-20, Precision Machine Specialties)	6
26	9022956-7	. ELECTRODE, Special tool, 0.062 IN. DIA x 0.150 (Alternate MRP-63-06-70)	12
27	NAS679C04W	. NUT	4
28	9022953	. SCREW, Special tool	5
29	9022952	. FASTENER, Special tool (0.690 IN. overall length)	5
30	9022902	. FASTENER, Special tool (0.450 IN. overall length)	5
31	9022932-3	. BRUSH, Special tool (0.250 IN. shank DIA x 0.744 IN.)	1
32	9022882-3	. BRUSH, Special tool (0.312 IN. shank DIA x 0.475 IN.)	1
33	9022882-5	. BRUSH, Special tool (0.312 IN. shank DIA x 0.896 IN.)	1
34	9022932-5	. BRUSH, Special tool (0.250 IN. shank DIA x 0.870 IN.)	1

Figure 14-1. Single-Head Special Toolkit (Not Incorporating MD2 Change) (Sheet 3 of 3)



INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
	G3127	SPECIAL TOOL KIT, Single head	
1	796	. BOX (Creative Packaging Inc)	1
	9022967-21	. CONTAINER ASSY, Special tool	1
3	VD192-0007-0029	. . CONTAINER (Navan Products Inc)	1
4	9022967-15	. . CUSHION, Container Assy, special tool	1
5	9022967-13	. . CUSHION, Container Assy, special tool	1
6	9022887	. CLAMP ASSY, Support, special tool	1
7	620	. BOX (Creative Packaging Inc)	6
8	9026708	. CUTTER ASSY, Tube, 3/4 IN. (Alternate . . . . . CTC-AL-106, Precision Machine Specialties)	1
9	9026707	. CUTTER ASSY, Tube, 5/8 IN. (Alternate . . . . . CTC-AL-105, Precision Machine Specialties)	1
10	9026706	. CUTTER ASSY, Tube, 1/2 IN. (Alternate . . . . . CTC-AL-104, Precision Machine Specialties)	1
11	9026705	. CUTTER ASSY, Tube, 3/8 IN. (Alternate . . . . . CTC-AL-103, Precision Machine Specialties)	1
12	9026704	. CUTTER ASSY, Tube, 1/4 IN. (Alternate . . . . . CTC-AL-102, Precision Machine Specialties)	1
13	9022910	. SHAFT ASSY, Flexible, 1/4 tubing, special tool . . .	1
14	9022929	. CLAMP ASSY, Support, special tool	1
15	5404-04X-N7	. COUPLER (Symetrics Inc)	1
16	5104-04X-N7	. NIPPLE (Symetrics Inc)	1
17	9022926-31	. HEAD ASSY, 5/8 THRU 1.00, special tool	1
18	9022876-41	. HEAD ASSY, 1/4 THRU 1/2, special tool	1

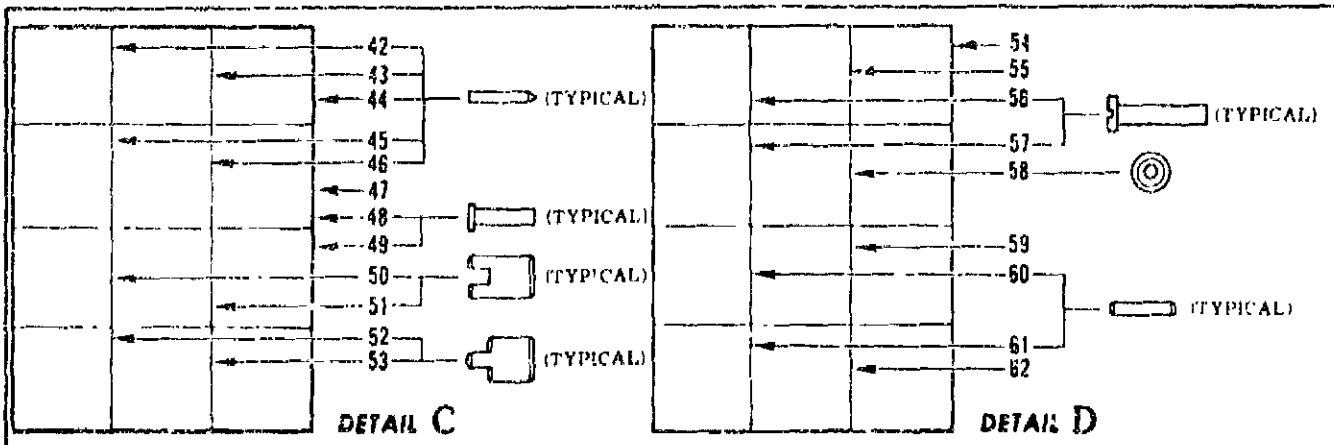
Figure 14-2. Single-Head Special Toolkit (Incorporating MD3 Change) (Sheet 1 of 5)



J2-5-1-104

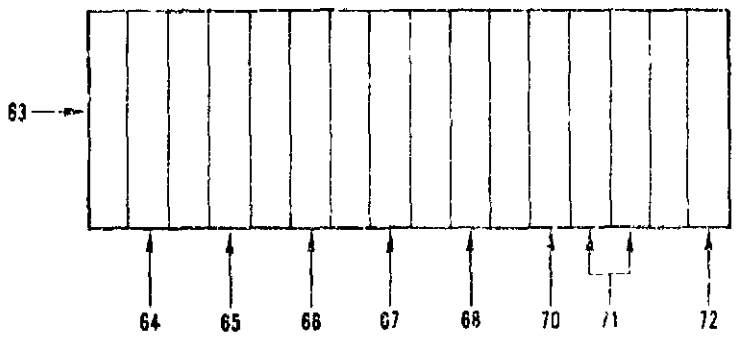
INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
19	203	. BOX (Creative Packaging Inc)	1
20	9026333-3	. PAD, Special tool kit	1
21	9027427	. GAGE ASSY, Adjustment, electrode	1
22	9027432	. BREAK OFF TOOL, Electrode, 040	1
23	9027431-37	. GAGE, Adjustment, electrode, male (-2007)	1
24	9027431-15	. GAGE, Adjustment, electrode, male (-2006)	1
25	9027431-13	. GAGE, Adjustment, electrode, male (-2005)	1
26	9027431-9	. GAGE, Adjustment, electrode, male (-1007)	1
27	9027431-35	. GAGE, Adjustment, electrode, male (-3006)	1
28	9027431-7	. GAGE, Adjustment, electrode, male (-0006)	1
29	9027431-33	. GAGE, Adjustment, electrode, male (-3005)	1
30	9027431-5	. GAGE, Adjustment, electrode, male (-0005)	1
31	9027431-3	. GAGE, Adjustment, electrode, male (-0004)	1
32	203	. BOX (Creative Packaging Inc)	1
33	9026333-5	. PAD, Special tool kit	1
34	9027427-11	. GAGE ASSY, Adjustment, electrode	1
35	9027433	. BREAK OFF TOOL, Electrode, 062	1
36	9027431-29	. GAGE, Adjustment, electrode, male (-6006)	1
37	9027431-25	. GAGE, Adjustment, electrode, male (-5006)	1
38	9027431-17	. GAGE, Adjustment, electrode, male (-3005)	1
39	9027431-27	. GAGE, Adjustment, electrode, male (-6005)	1
40	9027431-19	. GAGE, Adjustment, electrode, male (-3006)	1
41	9027431-23	. GAGE, Adjustment, electrode, male (4005)	1

Figure 14-2. Single-Head Special Toolkit (Incorporating MD3 Change) (Sheet 2 of 5)



INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
42	9022956-3	. ELECTRODE, Special tool, 0.062 IN. DIA x ..... 0.456 IN. (Alternate MRP-63-06-70)	12
43	9022956-5	. ELECTRODE, Special tool, 0.062 IN. DIA x ..... 0.592 IN. (Alternate MRP-63-06-70)	12
44	9022956-7	. ELECTRODE, Special tool, 0.062 IN. DIA x ..... 0.750 IN. (Alternate MRP-63-06-70)	12
45	9022906-5	. ELECTRODE, Special tool, 0.040 IN. DIA x ..... 0.460 IN. (Alternate MRP-63-06-79)	12
46	9022906-3	. ELECTRODE, Special tool, 0.040 IN. DIA x ..... 0.368 IN. (Alternate MRP-63-06-79)	12
47	204	. BOX (Bradley Industries Inc)	1
48	9022882-5	. BRUSH, Special tool (0.312 IN. shank DIA)	1
49	9022932-5	. BRUSH, Special tool (0.250 IN. shank DIA)	1
50	9026326	. COUPLING, Pinion, small head (0.500 IN. long) ..	1
51	9026328	. COUPLING, Pinion, large head (0.427 IN. long) ..	1
52	9026327	. COUPLING, Motor, small head (0.546 IN. ..... overall length)	1
53	9026329	. COUPLING, Motor, large head (0.615 IN. ..... overall length)	1
54	204	. BOX (Bradley Industries Inc)	1
55	NAS679C04W	. NUT	4
56	9022952	. FASTENER, Special tool (0.690 IN. overall length).	5
57	9022902-3	. FASTENER, Special tool (0.450 IN. overall length).	5
58	9026714	. CUTTER, Wheel, tube cutter, 1/4 THRU 3/4 .... (Alternate CW1-20, Precision Machine Specialties)	6
59	MS35233-3	. SCREW	10
60	9022918	. PIN, Special tool (0.093 IN. DIA x 0.375 IN.)	2
61	9022935	. PIN, Special tool (0.093 IN. DIA x 0.450 IN.)	2
62	4-40x3/32	. SOCKET SETSCREW (Cup point 18-8 type ..... 303 CRES)	4

Figure 14-2. Single-Head Special Toolkit (Incorporating MD3 Change) (Sheet 3 of 5)



DETAIL E

NOTE

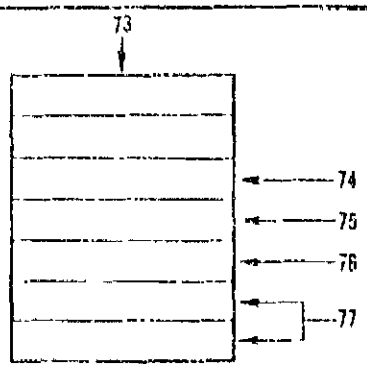
MAINTAIN COMPLETE SETS IN INDIVIDUAL BOXES

- THE INDICATED STORAGE INCLUDES A SET OF COVERS THAT MAY BE CURRENTLY INSTALLED ON THE LARGE HEAD ASSEMBLY
- STORE SPARE COVERS IN UNUSED BOXES.

12-5-1-101A

INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
63	1410	. BOX (Creative Packaging Inc)	10
64	9022908-177	. COVER, Special tool, top, inner	1
64	9022909-177	. COVER, Special tool, bottom, inner	1
64	9022920-177	. COVER, Special tool, bottom, outer	1
64	9022919-177	. COVER, Special tool, top, outer	1
65	9022908-175	. COVER, Special tool, top, inner	1
65	9022909-175	. COVER, Special tool, bottom, inner	1
65	9022920-175	. COVER, Special tool, bottom, outer	1
65	9022919-175	. COVER Special tool, top, outer	1
66	9022908-157	. COVER, Special tool, top, inner	1
66	9022909-157	. COVER, Special tool, bottom, inner	1
66	9022920-157	. COVER, Special tool, bottom, outer	1
66	9022919-157	. COVER, Special tool, top, outer	1
67	9022908-155	. COVER, Special tool, top, inner	1
67	9022909-155	. COVER, Special tool, bottom, inner	1
67	9022920-155	. COVER, Special tool, bottom, outer	1
67	9022919-155	. COVER, Special tool, top, outer	1
68	9022908-153	. COVER, Special tool, top, inner	1
68	9022909-153	. COVER, Special tool, bottom, inner	1
68	9022920-153	. COVER, Special tool, bottom, outer	1
68	9022919-153	. COVER, Special tool, top, outer	1
70	9022908-117	. COVER, Special tool, top, inner	1
70	9022909-117	. COVER, Special tool, bottom, inner	1
70	9022920-117	. COVER, Special tool, bottom, outer	1
70	9022919-117	. COVER, Special tool, top, outer	1
71	9022908-115	. COVER, Special tool, top, inner	1
71	9022909-115	. COVER, Special tool, bottom, inner	1
71	9022920-115	. COVER, Special tool, bottom, outer	1
71	9022919-115	. COVER, Special tool, top, outer	1
72	9022908-113	. COVER, Special tool, top, inner	1
72	9022909-113	. COVER, Special tool, bottom, inner	1
72	9022920-113	. COVER, Special tool, bottom, outer	1
72	9022919-113	. COVER, Special tool, top, outer	1

Figure 14-2. Single-Head Special Toolkit (Incorporating MD3 Change) (Sheet 4 of 5)



NOTE

MAINTAIN COMPLETE SETS IN INDIVIDUAL BOXES.

- THE INDICATED STORAGE INCLUDES A SET OF COVERS THAT MAY BE CURRENTLY INSTALLED ON THE LARGE HEAD ASSEMBLY
- STORE SPARE COVERS IN UNUSED BOXES.

J2-5 1 1071

INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
73	793	. BOX (Creative Packaging Inc)	7
74	9022958-117	. COVER, Special tool, top, inner	1
74	9022959-117	. COVER, Special tool, bottom, inner	1
74	9022962-117	. COVER, Special tool, bottom, outer	1
74	9022961-117	. COVER, Special tool, top, outer	1
75	9022958-183	. COVER, Special tool, top, inner	1
75	9022959-183	. COVER, Special tool, bottom, inner	1
75	9022962-183	. COVER, Special tool, bottom, outer	1
75	9022961-183	. COVER, Special tool, top, outer	1
76	9022958-159	. COVER, Special tool, top, inner	1
76	9022959-159	. COVER, Special tool, bottom, inner	1
76	9022962-159	. COVER, Special tool, bottom, outer	1
76	9022961-159	. COVER, Special tool, top, outer	1
77	9022958-137	. COVER, Special tool, top, inner	1
77	9022959-137	. COVER, Special tool, bottom, inner	1
77	9022962-137	. COVER, Special tool, bottom, outer	1
77	9022961-137	. COVER, Special tool, top, outer	1

Figure 14-2. Single-Head Special Toolkit (Incorporating MD3 Change) (Sheet 5 of 5)

Weight	25 pounds (approximately)
Height (closed)	8 inches
Width	29 inches
Depth	16 inches
Tube size cutting capability	1/4 to 3/4 inch
Tube size welding capability	1/4 to 1 inch all tube wall thicknesses found on the engine
Head assemblies 9022876 and 9022926	
Operating voltage (variable)	24-28 vdc
Drive pinion speed (no load)	20-25 rpm
Flexible shaft (used with large head assembly)	
Length	36 inches (approximately)
Bend radius (minimum)	5 inches

Figure 14-3. Leading Particulars for Single-Head Special Toolkit

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-406	1	7 January 1966
J2-655	2	25 February 1970
J2-713	3	8 March 1972

Figure 14-4. Configuration Changes--Manual Effectivity

14-7. MAINTENANCE OF SINGLE-HEAD SPECIAL TOOLKIT.

14-8. Planned field maintenance requirements for the single-head special toolkit are listed in figure 14-5. This figure lists the tasks to be performed, when the tasks are to be performed, and refers to the data necessary to accomplish these tasks.

14-9. REPAIR OF SINGLE-HEAD SPECIAL TOOLKIT COMPONENTS.

14-10. Repair of kit components consists of replacing defective parts with like-serviceable parts.

14-11. REPAIRING HEAD ASSEMBLIES.

14-12. Except for the following, no special instructions are required for disassembly or assembly of head assemblies. For head assemblies 9022876-11 and 9022926-11 see figure 14-6, and for head assemblies 9022876-41 and 9022926-31 see figure 14-7 for the relationship of head assembly parts and for the key to index numbers used in this procedure.

a. When replacing wire (26, figure 14-6, or 37, figure 14-7) springs (27, 28, figure 14-6), or spring (38, figure 14-7), use lead-tin solder SN60 or SN63 (Federal Specification QQ-S-571), or equivalent, and solder mating surfaces fully.

b. When disassembling head assemblies 9022876-11 and 9022926-11, it is necessary to loosen setscrew (17, figure 14-6) to remove motor (23). Setscrew (17) is accessible through an access hole in housing assembly (11).

c. When assembling head assembly 9022876-41, make sure gap between coupling (21, figure 14-7) and ring (20) is 0.04 to 0.06 inch to adequately engage couplings (21 and 26). If motor (33) does not seat against mounting block (23) at minimum gap (0.04 inch), reduce 0.04-inch gap in 0.01-inch increments until interference is eliminated.

d. When assembling head assembly 9022926-31, make sure gap between coupling (21) and ring (20) is 0.02 to 0.04 inch to adequately engage couplings (21 and 26). If motor (33) does not seat against mounting block (23) at minimum gap (0.02 inch), reduce 0.02-inch gap in 0.01-inch increments until interference is eliminated.

e. When assembling, torque the following screws to values noted:

Index and Figure No.	Torque (in-lb)
5, 14-7	0.50 ±0.10
6, 14-6	0.50 ±0.10
9, 14-7	6.00 ±0.30 (head assembly 9022926-31)
	3 (max) (head assembly 9022876-41)
10, 14-6	6.00 ±0.60 (head assembly 9022926-11)
	3 (max) (head assembly 9022876-11)
17, 14-6	1.0 ±0.1 (head assembly 9022926-11)
	1 (max) (head assembly 9022876-11)
20, 14-6	1.2 ±0.12
21, 14-6	1.2 ±0.12
23, 14-7	1.00 ±0.1
26 14-7	1.20 ±0.12 (head assembly 9022926-31)
	1.0 (max) (head assembly 9022876-41)
27, 14-7	1.20 ±0.12
29, 14-6	1.2 ±0.12
36, 14-6	1.2 ±0.12
39, 14-7	1.20 ±0.12
46, 14-7	1.00 ±0.10

14-13. REPAIRING TUBE CUTTER ASSEMBLIES.

14-14. Except for the following, no special instructions are required for disassembly or assembly of tube cutter assemblies. See figure 14-8 for relationship of tube cutter assembly parts and for key to index numbers used in this procedure.

a. When disassembling, make sure setscrew (12) is loosened a minimum of 4 turns or removed before pin (11) is removed.

b. Before installing pin (11), inspect pin for wear. Reject pin if wear is discernible with fingernail.

NOTE

Allowable alternate to tube cutter assemblies do not incorporate setscrew (12).

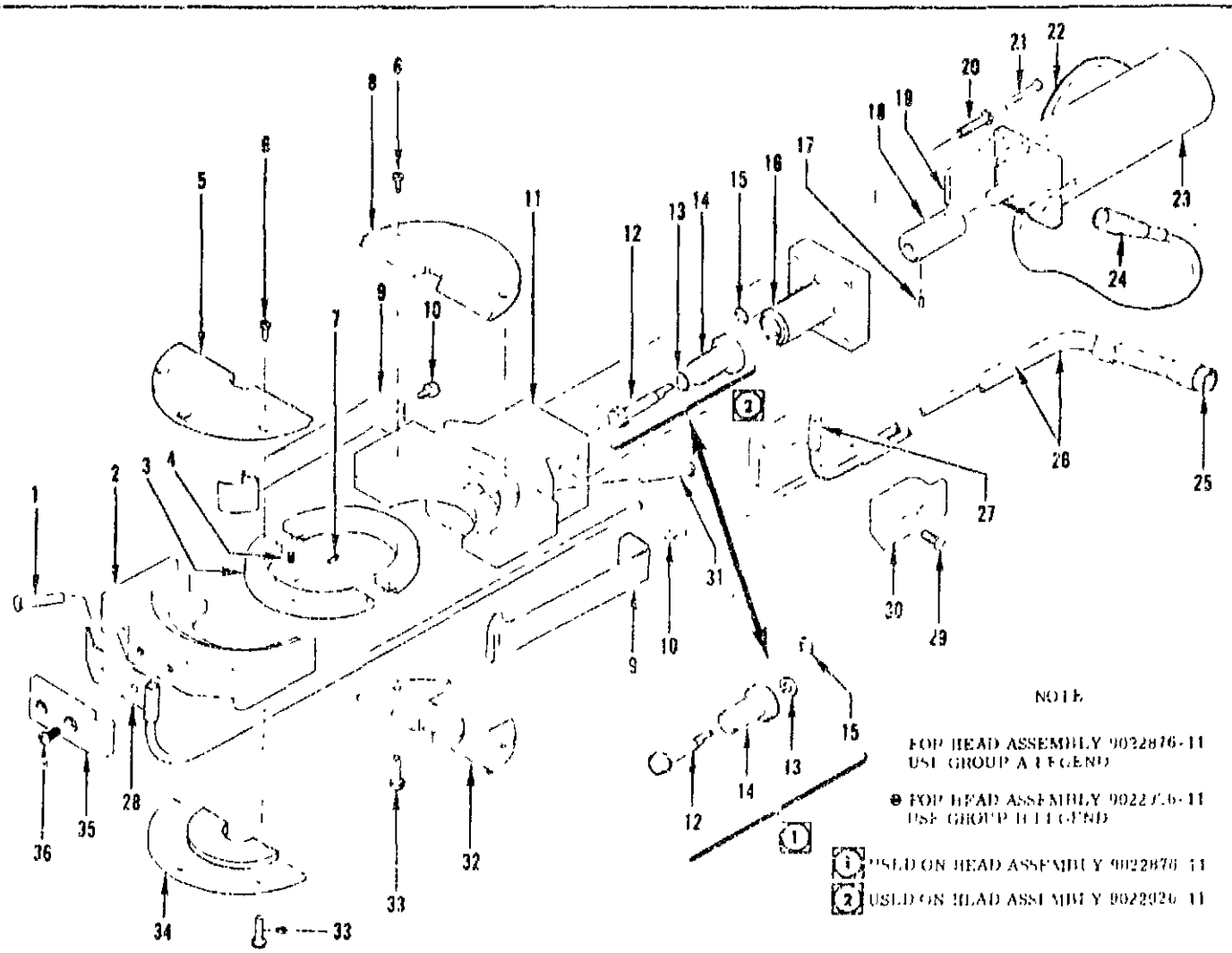
c. When assembling, lubricate (Method W, section I) pin (11) with lubricant grease RB0140-012 (Rocketdyne) and, if cutter incorporates setscrew (12), install lubricated pin (11) with flats toward setscrew.

d. When assembling, torque screw (7) to 133-163 in-oz and setscrew (12) to one in-lb maximum.

e. When assembling, make sure pins (6 and 11) and roller pins (5) are flush with or below surface of jaw segments.

Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
Inspect:					
Kit for completeness	X				See figure 14-1 or 14-2.
Brushes for freedom of movement and oxidization		X			Depress and release each brush. Brush must return freely immediately after release. Remove oxidization with a soft-bristle, wire brush. NOTE A wire brush with a 300 wire size is recommended.
Split rotors for wear		X			With rotor assembled, check for rotational movement of halves relative to each other. Since there is no set measurement that can determine whether the rotor should be replaced, performance is the determining factor. If more than 0.005-inch rotational movement exists, however, performance capability of the rotor must be carefully monitored during subsequent use.
Air passage for obstructions		X			Air passage must be clear. Check by applying low-pressure gaseous nitrogen (MIL-P-27401).
Tube cutters for freedom of movement	X	X			Service or replace parts that bind. Refer to paragraph 14-13.
Tube cutter cutter wheels for for nicks and cracks on cutting edge		X			Replace cutter wheel. Refer to paragraph 14-13.
Flexible shaft for rotation	X	X			Cable must rotate freely without evidence of binding. Clean cable and then lubricate cable lightly with general purpose grease (MIL-G-7711).
Rotors for weld residue		X			Remove weld residue. Ultrasonic cleaning is permissible.
Electrical cables for damaged insulation and damaged connectors		X			Replace cables and/or connectors. Refer to paragraph 14-11.
Lubricate:					
Tube cutter cutter wheel pin (11, figure 14-8). Cutter wheel pins that have been dry lubricated do not require periodic lubrication unless lubricant has worn to the extent that bare metal is exposed.)				X	Every 30 days or prior to next use, whichever provides the greater time interval. Refer to paragraph 14-13 for disassembly and assembly requirements.

Figure 14-5. Maintenance Requirements for Single-Head Special Toolkit


NOTE
FOR HEAD ASSEMBLY 9022876-11 USE GROUP A LEGEND
FOR HEAD ASSEMBLY 9022926-11 USE GROUP B LEGEND
USED ON HEAD ASSEMBLY 9022876-11
USED ON HEAD ASSEMBLY 9022926-11
J2 5 1 32A

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
		GROUP A	
	9022876-11	HEAD ASSY, 1/4 THRU 1/2 special tool	
1	9022882-3	. BRUSH, Special tool	1
2	9022881-11	. HOUSING ASSY, Top, special tool	1
3	9022905	. ROTOR, Special tool (Matched set) (Alternate 9027309) (See index 4 for proper setscrew)	1
4	AN565DC2H1	. SETSCREW (Use socket setscrew 4-40 unc thd x 3/32-inch with alternate rotor, index 3)	1
5	9022908-13	. COVER, Special tool, top, inner	1
6	AN505C2-4	. SCREW	5
7	9022906-5	. ELECTRODE, Special tool	1
8	9022909-13	. COVER, Special tool, bottom, inner	1
	9022893-11	. HEAD ASSY, Bottom, special tool	1
9	9022894	. . LATCH ASSY, Special tool	2
10	NAS1101-08-8	. . SCREW	2
11	9022897-11	. . HOUSING ASSY, Bottom, block special tool	1
	9022890	. . PINION ASSY, Special tool	1

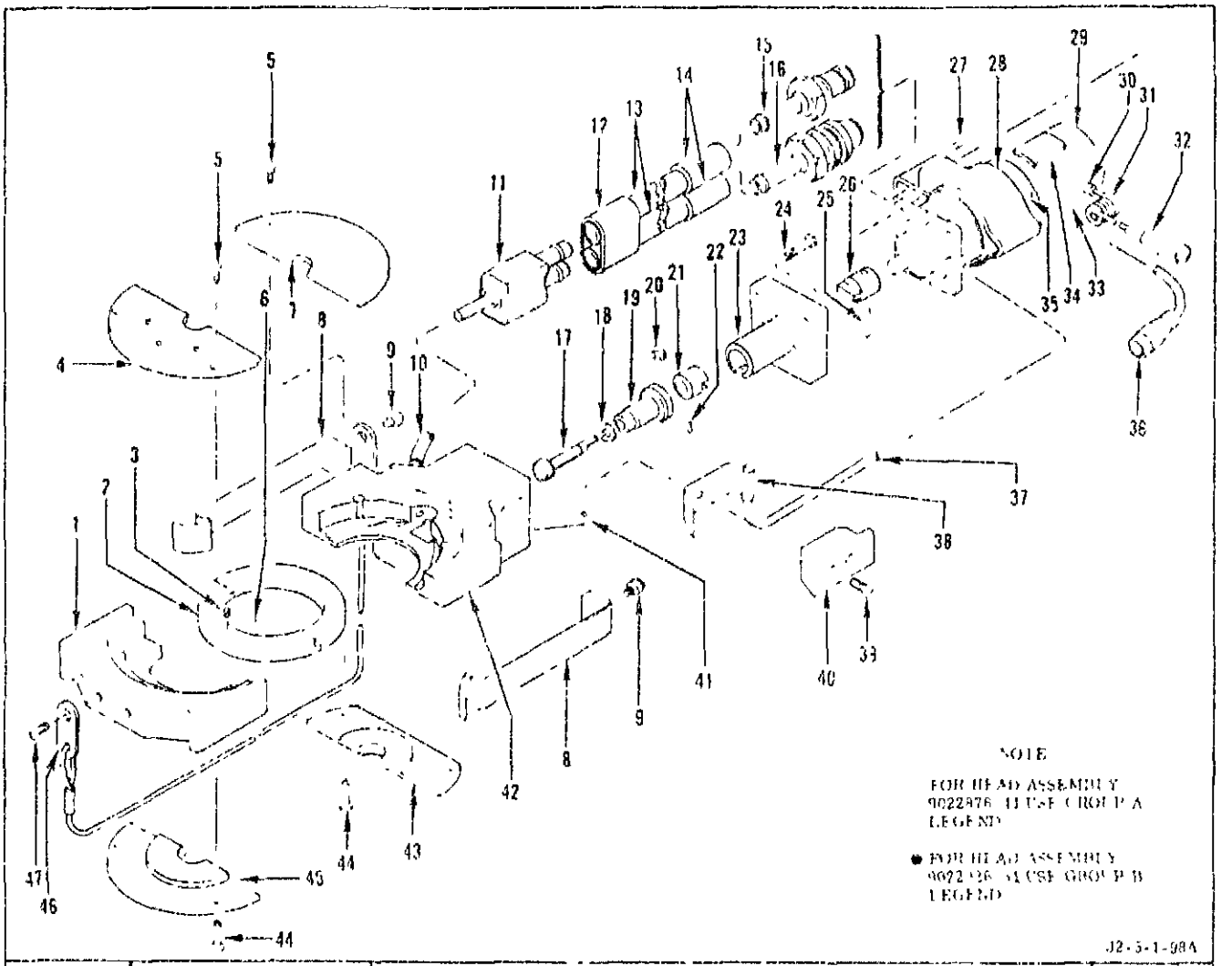
Figure 14-6. Head Assemblies 9022876-11 and 9022926-11 (Sheet 1 of 3)

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY.
12	9022891	. . . PINION, Special tool	1
13	9022893	. . . WASHER, Special tool	1
14	9022892	. . . BEARING, Special tool	1
15	MS16633-4012	. . . RING	1
16	9022898	. . BLOCK, Mounting, special tool	1
17	AN565DC4H2	. . SETSCREW (Alternate NAS1061C04D2L)	1
18	9022889	. . COUPLING ASSY, Motor, special tool (For spares 9022889-11 may be used)	1
19	9022918	. . PIN, Special tool	1
20	NAS1101-04-8	. . SCREW	4
21	NAS1101-04-5	. . SCREW	4
	9022888	. . MOTOR ASSY, Special tool	1
22	AB0150-004-22-3 Type 1 Class 1	. . . CABLE, 25.00 ±2.00 IN.	1
23	43A875	. . . MOTOR (Globe Industries) (Alternate 43A684, Globe Industries)	1
24	XLR-3-12C	. . . PLUG (ITT Cannon Electric Co)	1
	9022916-21	. CABLE ASSY, Special tool	1
25	JCSM-810	. . MALE CONNECTOR (Cam-Lok) (Replaces TWH200-2 Conn)	1
26	PAP52096	. . WIRE (Pacific Automation Prod) (Approx 115 IN.) (Replaces TWH-200-2 cable)	1
27	9022884	. . SPRING, Special tool, bottom	1
28	9022879	. . SPRING, Special tool, top	1
29	AN515-4-6	. SCREW	2
30	9022972	. INSULATOR, Special tool, side	1
31	9022882-5	. BRUSH, Special tool	1
32	9022920-13	. COVER, Special tool, bottom, outer	1
33	9022902	. FASTENER, Special tool	5
34	9022919-13	. COVER, Special tool, top, outer	1
35	9022880	. INSULATOR, Special tool, top	1
36	AN515-4-6	. SCREW	2
		GROUP B	
	9022926-11	HEAD ASSY, 5/8 THRU 1.00, special tool	
1	9022932-3	. BRUSH, Special tool	1
2	9022931-11	. HOUSING ASSY, Top, special tool	1
3	9022955	. ROTOR ASSY, Special tool (Alternate 9027337) (See index 4 for proper setscrew)	1
4	AN565DC2H2	. SETSCREW (Use socket setscrew 4-40 unc thd x 3/32-inch with alternate rotor, index 3)	1
5	9022958-13	. COVER, Special tool, top, inner	1
6	9022953	. SCREW, Special tool	5
7	9022956-3	. ELECTRODE, Special tool	1

Figure 14-6. Head Assemblies 9022876-11 and 9022926-11 (Sheet 2 of 3)

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY.
8	9022959-13	. COVER, Special tool, bottom, inner	1
	9022933-11	. HEAD ASSY, Special tool, bottom	1
9	9022944	. . LATCH ASSY, Special tool	2
10	NAS1101-3-8	. . SCREW	2
11	9022947-11	. . HOUSING ASSY, Bottom, special tool	1
	9022940	. . PINION ASSY, Special tool	1
12	9022941	. . . PINION, Special tool	1
13	9022893	. . . WASHER, Special tool	1
14	9022942	. . . BEARING, Special tool	1
15	MS16633-4012	. . . RING	1
16	9022948	. . BLOCK, Mounting, special tool	1
17	AN565DC4H2	. . SCREW (Alternate NAS1081C04D2L)	1
18	9022939	. . COUPLING, Special tool	1
19	9022935	. . PIN, Special tool	1
20	NAS1101-04-8	. . SCREW	4
21	AN500D4-8	. . SCREW	4
	9022937	. . MOTOR ASSY, Special tool	1
22	AB0150-004-22-3 Type 1 Class 1	. . . CABLE, 96.00 ±3.00 IN.	1
23	9022937-3	. . . MOTOR, Special tool	1
24	XLR-3-12C	. . . PLUG (ITT Cannon Electric Co)	1
	9022927-11	. CABLE ASSY, Special tool	1
25	JCSM-810	. . MALE CONNECTOR (Cam-Lok) (Replaces TWH200-2 Conn)	1
26	PAP52096	. . WIRE (Pacific Automation Prod) (Approx 115 IN.) (Replaces TWH-200-2 cable)	1
27	9022934	. . SPRING, Special tool, bottom	1
28	9022928	. . SPRING, Special tool, top	1
29	AN515-4-7	. SCREW	2
30	9022974	. INSULATOR, Special tool, side	1
31	9022932-5	. BRUSH, Special tool	1
32	9022962-13	. COVER, Special tool, bottom, outer	1
33	9022952	. FASTENER, Special tool	5
34	9022961-13	. COVER, Special tool, top, outer	1
35	9022973	. INSULATOR, Special tool, top	1
36	AN515-4-5	. SCREW	2

Figure 14-6. Head Assemblies 9022876-11 and 9022926-11 (Sheet 3 of 3)



INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
		GROUP A	
	9022876-41	HEAD ASSY, 1/4 THRU 1/2 special tool	
1	9022881-31	. HOUSING ASSY, Top, special tool	1
2	9027300-11	. ROTOR ASSY, Ring, (Matched set)	1
3	4-40 UNC THD x 3/32 IN.	. SOCKET, Setscrew, cup point JB-8 type 303 CRES	1
4	9022908-115	COVER, Special tool, top, inner	1
5	MS35233-3	. SCREW	4
6	9022906-5	. ELECTRODE, Special tool (Alternate, bulk electrode MRP-03-06-79)	1
7	9022909-115	. COVER, Special tool, bottom, inner	1
8	9022894-11	. LATCH ASSY, Special tool	2
9	NAS1101-08-8	. SCREW	2

Figure 14-7. Head Assemblies 9022876-41 and 9022926-31 (Sheet 1 of 4)

INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
10	V1-562 x 1.50	. TUBE (Samuel Moore & Co)	1
	9027437-21	. ADAPTER ASSY, Head purge	1
11	No Number	. . SUBASSEMBLY, Welded (Comprises 9027437-7, -9, and -13)	1
12	9027437-23	. . TUBE	1
13	9027437-15	. . TUBE	2
14	9027437-25	. . TUBE	2
15	5104-04X-N7	. . NIPPLE (Symetrics Inc)	1
16	5404-04X-N7	. . COUPLER (Symetrics Inc)	1
	9022890-11	. PINION ASSY, Special tool	1
17	9022891	. . PINION, Special tool	1
18	9022893-3	. . WASHER, Special tool	1
19	9022892-3	. . BEARING, Special tool	1
20	MS16633-4012	. . RING	1
21	9026326	. COUPLING, Pinion, small head	1
22	NAS1081C04D2L	. SCREW	1
23	9022898	. BLOCK, Mounting, special tool	1
24	NAS1101-04-8	. SCREW	4
25	9022918	. PIN, Special tool	1
26	9026327	. COUPLING, Motor, small head	1
27	NAS1101-04-5	. SCREW	4
28	NT1-1/2 x 1.00	. TUBE (Raychem Corp)	1
29	43A1054	. MOTOR ASSY (Globe Industries) (Alternate 9022888-11)	1
30	NT1/4 x .75	. . TUBE (Raychem Corp) (Used on 9022888-11)	1
31	9-4001-14-91	. . COILED KORD (Whitney Blake Co) (Alternate 9-4001-23-91) (Used on 9022888-11)	1
32	XLR-3-12C	. . PLUG (ITT Cannon Electric Co) (Used on 9022888-11)	1
33	9022888-3	. . MOTOR ASSY, Special tool (Altered from Globe Ind 43A875 or 43A684) (Used on 9022888-11)	1
34	9026335	. . PLATE, Identification (Used on 9022888-11)	1
34	9026335	. PLATE, Identification	1
35	NT7/8 x 1.25	. TUBE (Raychem Corp)	1
	9022916-31	. CABLE ASSY, Special tool	1
36	JCSM-810	. . MALE CONNECTOR (Cam-Lok)	1
37	PAP52096	. . WIRE (Pacific Automation Prod) (Approx 24 IN.)	1
38	9022884	. . SPRING, Special tool, bottom	1
39	MS35233-15	. SCREW	2
40	9022972-3	. INSULATOR, Special tool, side	1
41	9022882-5	. BRUSH, Special tool	1
42	9022897-31	HOUSING ASSY, Bottom, block special tool	1
43	9022920-115	. COVER, Special tool, bottom, outer	1
44	9022902-3	. FASTENER, Special tool	4
45	9022919-115	. COVER, Special tool, top, outer	1
46	9026330	. LANYARD ASSY, Special toolkit	1
47	NAS1102-04-5	. SCREW	1

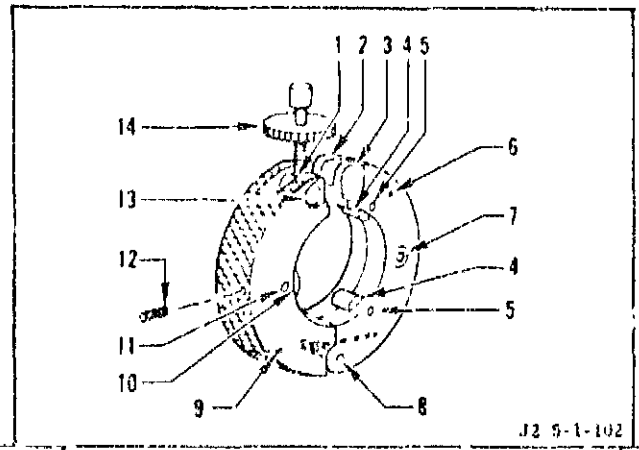
Figure 14-7. Head Assemblies 9022876-41 and 9022926-31 (Sheet 2 of 4)

INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
		GROUP B	
	9022926-31	HEAD ASSY, 5/8 THRU 1.00 special tool	
1	9022931-21	. HOUSING ASSY, Top, special tool	1
2	9027337-11	. ROTOR ASSY, Ring, (Matched set)	1
3	4-40 UNC THD x 3/32 IN.	. SOCKET, Setscrew, cup point 18-8 type 303 CRES	1
4	9022958-137	. COVER, Special tool, top, inner	1
5	MS35233-3	. SCREW	4
6	9022956-3	. ELECTRODE, Special tool (Alternate, bulk electrode MRP-63-06-70)	1
7	9022959-137	. COVER, Special tool, bottom, inner	1
8	9022944	. LATCH ASSY, Special tool	2
9	NAS1101-3-8	. SCREW	2
10	V1-562 x 2.50	. TUBE (Samuel Moore & Co)	1
	9027437-21	. ADAPTER ASSY, Head purge	1
11	No Number	. . SUBASSEMBLY, Welded (Comprises 9027437-7, -9, and -13)	1
12	9027437-23	. . TUBE	1
13	9027437-15	. . TUBE	2
14	9027437-25	. . TUBE	2
15	5104-04X-N7	. . NIPPLE (Symetrics Inc)	1
16	5404-04X-N7	. COUPLER (Symetrics Inc)	1
	9022940-11	. PINION ASSY, Special tool	1
17	9022941	. . PINION, Special tool	1
18	9022893-7	. . WASHER, Special tool	1
19	9022942-3	. . BEARING, Special tool	1
20	MS16633-4012	. . RING	1
21	9026328	. COUPLING, Pinion, large head	1
22	NAS1081C04D2L	. SCREW	1
23	9022948	. BLOCK, Mounting, special tool	1
24	NAS1101-04-6	. SCREW	4
25	9022935	. PIN, Special tool	1
26	9026329	. COUPLING, Motor, large head	1
27	AN500D4-8	. SCREW	4
28	NT2 x 1.00	. TUBE (Raychem Corp)	1
29	5A2732	. MOTOR ASSY (Globe Industries) (Alternate 9022937-11)	1
30	NT1/4 x .75	. . TUBE (Raychem Corp) (Used on 9022937-11)	1
31	9-4001-14-91	. . COILED CORD (Whitney Blake Co) (Alternate 9-4001-23-91) (Used on 9022937-11)	1
32	XLR-3-12C	. . PLUG (ITT Cannon Electric Co) (Used on 9022937-11)	1
33	9022937-5	. . MOTOR ASSY, Special tool (Altered from Globe Ind 5A2188) (Used on 9022937-11)	1

Figure 14-7. Head Assemblies 9022976-41 and 9022926-31 (Sheet 3 of 4)

INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.
34	9026335	. . PLATE, Identification (Used on 9022937-11) ...	1
34	9026335	. PLATE, Identification	1
35	NT1-1/2 x 1.25	. TUBE (Raychem Corp)	1
	9022927-31	. CABLE ASSY, Special tool	1
36	JCSM-810	. . MALE CONNECTOR (Cam-Lok)	1
37	PAP52096	. . WIRE (Pacific Automation Prod) (Approx 24 IN.).	1
38	9022934	. . SPRING, Special tool, bottom	1
39	AN515-4-7	. SCREW	2
40	9022974	. INSULATOR, Special tool, side	1
41	9022932-5	. BRUSH, Special tool	1
42	9022947-21	HOUSING ASSY, Bottom, special tool	1
43	9022962-137	. COVER, Special tool, bottom, outer	1
44	9022952	. FASTENER, Special tool	4
45	9022961-137	. COVER, Special tool, top, outer	1
46	9026330	. LANYARD ASSY, Special toolkit	1
47	NAS1102-04-5	. SCREW	1

Figure 14-7. Head Assemblies 9022875-41 and 9022926-31 (Sheet 4 of 4)



INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.				
	9026704	CUTTER ASSY, Tube, 1/4 IN. . . . . (Alternate CTC-AL-102, Precision Machine Specialties)	REF				
	9026705	CUTTER ASSY, Tube, 3/8 IN. . . . . (Alternate CTC-AL-103, Precision Machine Specialties)		REF			
	9026706	CUTTER ASSY, Tube, 1/2 IN. . . . . (Alternate CTC-AL-104, Precision Machine Specialties)			REF		
	9026707	CUTTER ASSY, Tube, 5/8 IN. . . . . (Alternate CTC-AL-105, Precision Machine Specialties)				REF	
	9026708	CUTTER ASSY, Tube, 3/4 IN. . . . . (Alternate CTC-AL-106, Precision Machine Specialties)					REF
	9026723	. CUTTER ASSY, Tube, ... 1/4 IN.	1				
	9026724	. CUTTER ASSY, Tube, ... 3/8 IN.		1			
	9026725	. CUTTER ASSY, Tube, ... 1/2 IN.			1		
	9026699	. CUTTER ASSY, Tube, ... 5/8 IN.				1	
	9026700	. CUTTER ASSY, Tube, ... 3/4 IN.					1
1	9026723-3	. . UPPER JAW	1				
1	9026724-7	. . UPPER JAW		1			
1	9026725-3	. . UPPER JAW			1		
1	9026699-3	. . UPPER JAW				1	
1	9026700-3	. . UPPER JAW					1
2	9026723-5	. . LOWER JAW SEGMENT	1				
2	9026724-5	. . LOWER JAW SEGMENT		1			
2	9026725-7	. . LOWER JAW SEGMENT			1		
2	9026699-5	. . LOWER JAW SEGMENT				1	
2	9026700-5	. . LOWER JAW SEGMENT					1

Figure 14-8. Tube Cutter Assemblies (Sheet 1 of 2)

INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY.				
3	9026723-7	. . LOWER JAW SEGMENT	1				
3	9026724-3	. . LOWER JAW SEGMENT		1			
3	9026725-5	. . LOWER JAW SEGMENT			1		
3	9026699-7	. . LOWER JAW SEGMENT				1	
3	9026700-7	. . LOWER JAW SEGMENT					1
4	B-2[illegible]	. . BEARING (Torrington Co) ...	2	2	2	2	2
5	9026719	. . PIN, Roller, tube cutter, ... 1/4 THRU 3/4 IN.	2	2	2	2	2
6	MS16555-606	. . PIN	1	1	1	1	1
7	ND112-0001-0303	. . SCREW	1	1	1	1	1
8	RD122-3001-0708	. . PIN	1	1	1	1	1
9	9026715	. . SPRING, Tube cutter, ... 1/4 THRU 3/4 IN.	1	1	1	1	1
10	9026714	. CUTTER, Wheel, tube cutter, .. 1/4 THRU 3/4 IN. (Alternate CW1-20)	1	1	1	1	1
11	9026712	. PIN, Dowel, tube cutter, ... 1/4 THRU 3/4 IN.	1	1	1	1	1
12	NAS1061-02A4	. SETSCREW	1	1	1	1	1
13	9026716	. NUT, Barrel, tube cutter, ... 1/4 THRU 3/4 IN.	1	1	1	1	1
14	9026717-3	. THUMBSCREW, Tube cutter, ... 1/4 IN.	1				
14	9026717-5	. THUMBSCREW, Tube cutter. ... 3/8 IN.		1			
14	9026718	. THUMBSCREW, Tube cutter, ... 1/2 THRU 3/4 IN.			1	1	1

Figure 14-8. Tube Cutter Assemblies (Sheet 2 of 2)

SECTION XV

PROPELLANT UTILIZATION VALVE VOLTAGE ADJUST AND MONITORING TEST UNIT 9025664

TABLE OF CONTENTS

PARAGRAPH		PAGE
15-1	Description and Leading Particulars of Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit	15-1
15-3	Maintenance and Repair of Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit	15-1
15-5	Continuity-Testing Controller and Harness Adapter . . .	15-2
15-6	Function-Testing Controller	15-2
15-7	Repairing Test Unit	15-2
15-8	Storage	15-2

15-1. DESCRIPTION AND LEADING PARTICULARS OF PROPELLANT UTILIZATION VALVE VOLTAGE ADJUST AND MONITORING TEST UNIT.

15-2. The propellant utilization valve voltage adjust and monitoring test unit consists of propellant utilization valve voltage controller 9026620, propellant utilization valve wiring harness adapter 9026619, and container VD192-0007-0020 (Navan, Inc). (See figure 15-1 for leading particulars.) The voltage controller is an adjustable Variac autotransformer, which, when connected to Electrical Checkout Console G1037, controls the console input voltage and, in turn, controls the output voltage to the propellant utilization valve. The wiring harness adapter provides an interconnect between connectors J3 and J13 of electrical checkout console to permit monitoring of the console output voltage (to propellant utilization valve) at 115 VAC 400 CYCLE test jacks mounted on the front of the console SIMULATOR panel.

15-3. MAINTENANCE AND REPAIR OF PROPELLANT UTILIZATION VALVE VOLTAGE ADJUST AND MONITORING TEST UNIT.

15-4. Maintenance requirements for the propellant utilization valve voltage adjust and monitoring test unit are listed in figure 15-2. The figure lists the tasks required, when the tasks are to be performed, and provides paragraph references necessary to accomplish these tasks.

15-5. CONTINUITY-TESTING CONTROLLER AND HARNESS ADAPTER. Check continuity between contacts as indicated in figure 15-3. Use ohms setting of meter Model 630-A (Triplett), Model 260 (Simpson), or equivalent. All continuity indications must be less than one ohm. Open case of autotransformer 9026621 only if a malfunction is suspected.

15-6. FUNCTION-TESTING CONTROLLER. The function test of the voltage controller consists of applying power and operating the controller through its output range. (See figure 15-1.) Monitor the output by connecting an ungrounded meter, Model 630-A (Triplett), Model 260 (Simpson), or equivalent, to test jacks 0-115 VAC located on side of controller assembly 9026620.

15-7. REPAIRING TEST UNIT. Use standard electrical procedures to repair the test unit. (Special instructions are not provided.) Refer to figure 15-3 for wiring connections and to R-3825-3 for inspecting, straightening, and cleaning electrical connectors. Perform a continuity test and function test after any repair affecting functional components of the controller or harness adapter.

15-8. STORAGE. Store the controller and harness adapter in container VD192-0007-0020.

Dimensions (of controller)	
Height	5-1/2 inches (approx)
Width	5-1/2 inches (approx)
Depth	6-1/2 inches (approx)
Length of cable	91 inches (approx)
Weight	3-1/2 pounds (approx)
Power requirements (input)	
Alternating current	115 ±5 volts, 400 ±4 cps having less than 3-percent distortion. Phase to pin A and neutral to pin B of connector J4A. Pin D of J4A is chassis ground.
Ampere rating	2 amperes
Output range	Variable between a minimum of less than one volt and a maximum of input voltage
Length (of harness adapter)	96 inches (approx)

Figure 15-1. Leading Particulars for Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit

Requirements	Receiving	Prior to Use	Storage	Special	Remarks
Inspect test unit for completeness.	X	X			Refer to paragraph 15-1.
Inspect electrical cables for broken or frayed insulation, broken wires.		X			Repair as necessary. (Refer to paragraph 15-7.)
Inspect electrical connectors for bent or damaged contacts.		X			Refer to R-3825-3.
Inspect components for cleanness.		X			Clean as necessary. Refer to cleaning, section I.
Check wiring harness adapter for continuity.				X	Every 6 months. Refer to paragraph 15-6. Repair as necessary.
Function-test controller.				X	Every 6 months. Refer to paragraph 15-6.

Figure 15-2. Maintenance Requirements for Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit

From	Contact	To	Contact
J4A	A	Transformer[a]	4
J4A	B	Transformer[a]	2
J4A	B	0-115 AC	N
J4A	B	P4A	B
J4A	C	None	
J4A	D	Chassis ground	
J4A	D	P4A	D
P4A	A	0-115 AC	Ø
P4A	A	Transformer[a]	3
J3A	A	None	
J3A	B	None	
J3A	C	P3A	C
J3A	C	P13	C
J3A	D	P3A	D
J3A	D	P13	D
J3A	E	P3A	E
J3A	E	P13	E
J3A	F	None	
J3A	G	P3A	G
J3A	H	P3A	H
J3A	J	P3A	J
J3A	K	P3A	K
J3A	L	P3A	L
J3A	M	None	
J3A	N	None	
J3A	P	P3A	P
J3A	P	P13	P
J3A	R	P3A	R
J3A	R	P13	R
J3A	S	P3A	S
J3A	T	P3A	T

(a) Do not check unless a malfunction is suspected.

Figure 15-3. Controller and Harness Adapter Wire Terminals

MANUAL DATA SUPPLEMENTS

Manual Data Supplements are issued from time to time to communicate important and urgent information concerning the equipment covered in this volume. These supplements bear an identifying number and should be filed in this Appendix.

Manual Data Supplements directly affect the data in this volume and will be incorporated into this volume during a future updating effort.

A Supplement Record is issued periodically to indicate the status of supplements issued for this volume. The status of each supplement is indicated in the "Supplement Status" column. For active supplements, no status is entered. For incorporated supplements, "Incorporated" is entered.

Upon receipt of a Manual Data Supplement, make an appropriate reference to the supplement in the margin next to the data supplemented and enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record.

MANUAL DATA SUPPLEMENT RECORD

This Manual Data Supplement Record indicates the status of supplements issued for Technical Manual R-3825-5, Volume I. Supplements that have been incorporated into this volume shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
1	3 June 1965	Part I. Provides one-time inspection requirements for warning light. Part II. Adds installation and inspection requirements for warning light bulb replacement.	Canceled Incorporated
2	15 July 1965	Corrects checkout procedures.	Incorporated
3	29 July 1965	Expands on requirement to remove pressure plugs.	Incorporated
4	13 August 1965	Corrects checkout procedures.	Incorporated
5	20 August 1965	Adds alternate allowable bolt and repair procedures.	Incorporated
R-3825-5 Vol I-6	24 September 1965	Corrects checkout procedure for Flight Instrumentation Checkout Console G1035.	Incorporated
R-3825-5 Vol I-7	11 October 1965	Corrects checkout procedure for Data Recorder Console G3121.	Incorporated
R-3825-5 Vol I-8	29 November 1965	Provides inspection and rework of temperature indicator on G3107 to bring indicator up to latest change.	Canceled
R-3825-5 Vol I-9	27 December 1965	Corrects checkout procedure for Inert Gas Arc Welding Set G3128 and Single Head Special Tool Kit G3127.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-5 Vol I-10	24 March 1966	Provides additional adjustment procedures for recording oscillograph on Data Recorder Console G3121 incorporating MD4 or MD5 change.	Incorporated
R-3825-5 Vol I-11	12 April 1966	Changes test procedure for Electrical Checkout Console G1037.	Incorporated
R-3825-5 Vol I-12	18 April 1966	Updates inspection requirements chart for Data Recorder Console G3121, and corrects two steps in checkout procedure for Electrical Checkout Console G1037.	Incorporated
R-3825-5 Vol I-13	22 June 1966	Establishes clean requirements for burst diaphragms.	Incorporated
R-3825-5 Vol I-14	30 June 1966	Adds a warning against operation of Automatic Inert Gas Arc Welding Set G3128 in a wet environment.	Incorporated
R-3825-5 Vol I-15	24 August 1966	Changes requirements for liquid relief valves and timer, switch positions, and electrode tips.	Incorporated
R-3825-5 Vol I-16	17 October 1966	Establishes requirement to tape welding adapters when O-rings have been removed in compliance with EFIR J2-13.	Incorporated
R-3825-5 Vol I-17	20 October 1966	Removes requirement to effect acceptance welds with weld schedule values, and establishes these values as recommended initial settings.	Incorporated
R-3825-5 Vol I-18	7 November 1966	Changes a resistance value in checkout procedure of Electrical Checkout Console G1037. Corrects connector and pin numbers in checkout procedure for Flight Instrumentation Checkout Console G1035. Adds procedure for adjusting temperature panel power supply on Component Test Console G3107.	Incorporated
R-3825-5 Vol I-19	28 November 1966	Adds requirement for periodic lubrication of certain hand valves on Components Test Console G3107.	Incorporated
R-3825-5 Vol I-20	17 February 1967	Adds information to allow Automatic Inert Gas Arc Welding Set G3128 to be used to perform fillet welds.	Incorporated
R-3825-5 Vol I-21	13 March 1967	Incorporates ECP J2-563 (MD5 change), which adds an insulated ground strap to Automatic Inert Gas Arc Welding Set G3128.	Incorporated

Supplement Number	Date	Description	Supplement Status
R-3825-5 Vol I-22	12 April 1967	Incorporates a procedure for replacing or rebonding Throat Plug G3120 pad.	Incorporated
R-3825-5 Vol I-23	16 August 1967	Adds disassembly procedure, lubrication requirements, and allowable alternates for tube cutter assemblies.	Incorporated
R-3825-5 Vol I-24	13 November 1967	Changes procedure for function-testing vibration safety cutoff unit.	Incorporated
R-3825-5 Vol I-25	20 November 1967	Changes proof-pressure requirements, and adds a leak-test for flexible hoses.	Incorporated
R-3825-5 Vol I-26	21 November 1967	Adds information for insulating current cable connecting couplings, and clarifies use of materials to isolate welding cables.	Incorporated
R-3825-5 Vol I-27	30 January 1968	Adds information for data recorder console recording oscillographs incorporating a galvanometer indicator light, and clarifies operation of takeup reel indicator light during function testing.	Incorporated
R-3825-5 Vol I-28	30 January 1968	Changes List of Effective Pages, and replaces existing pages that may have been removed from manual.	Incorporated
R-3825-5 Vol I-29	12 February 1968	Changes procedure for function-testing vibration safety cutoff unit.	Incorporated
R-3825-5 Vol I-30	28 March 1968	Adds a requirement to provide a safety earth ground to Electrical Checkout Console G1037.	Incorporated
R-3825-5 Vol I-31	29 March 1968	Illustrates required angle for grounding electrode tip used with Automatic Inert Gas Arc Welding Set G3128.	Incorporated
R-3825-5 Vol I-32	27 March 1968	Changes requirements for replacing and rebonding throat plug pads of Thrust Chamber Throat Plug Kit G3120.	Incorporated
R-3825-5 Vol I-33	10 April 1968	Corrects schedule numbers in figure 13-9, Welding Schedule.	Incorporated
R-3825-5 Vol I-34	29 April 1968	Changes function-testing procedures for pressure control purge panel on Automatic Inert Gas Arc Welding Sets G3128 incorporating MD6 change.	Incorporated
R-3825-5 Vol I-35	14 June 1968	Changes lubricant, and adds a periodic lubrication and inspection requirement to Single Head Special Tool Kit G3127 tube cutters.	Incorporated

Supplement Number	Date	Description	Supplement Status
R-3825-5 Vol I-36	29 June 1968	Changes function-testing procedures for Automatic Inert Gas Arc Welding Set G3128 pressure control purge panel.	Incorporated
R-3825-5 Vol I-37	8 August 1968	Adds an alternate material callout for test plate flanges.	Incorporated
R-3825-5 Vol I-38	16 September 1968	Adds proof-test requirements for Automatic Inert Gas Arc Welding Set G3128 hoisting sling assembly.	Incorporated
R-3825-5 Vol I-39	14 October 1968	Changes procedure for function-testing Vibration Safety Cutoff Unit G1038.	Incorporated
R-3825-5 Vol I-40	19 March 1969	Adds a requirement to perform a resistance check of a calibrated arc-current ammeter for power supply of Welding Set G3128 prior to installation of meter.	Incorporated
R-3825-5 Vol I-41	4 August 1971	Deletes requirements to leak-test test plates, adapters, plugs, and metering valve.	Incorporated
R-3825-5 Vol I-42	26 May 1972	Changes functional test procedures for Electrical Checkout Console G1037, Flight Instrumentation Checkout Console G1035, and Data Recorder Console G3121.	Incorporated
R-3825-5 Vol I-43	13 June 1972	Changes pressure limit for pressurized gases to be considered low-pressure.	Incorporated
R-3825-5 Vol I-44	13 December 1972	Adds requirement to periodically visually inspect exposed relay contacts in Automatic Inert Gas Arc Welding Set G3128.	Incorporated
R-3825-5 Vol I-45	25 January 1973	Adds schematic and wiring diagram and functional-test procedure changes for Electrical Checkout Console G1037 required by ECP J2-701R1.	Incorporated
R-3825-5 Vol I-46	13 April 1973	Adds warnings for handling specific materials.	Incorporated
R-3825-5 Vol I-47	16 April 1973	Changes leak-test compound (MIL-L-25567) to leak-test compound (MSFC-SPEC-384).	Incorporated
R-3825-5 Vol I-48	27 April 1973	Changes the requirement to calibrate the Automatic Inert Gas Arc Welding Set G3128 periodically to when acceptable welds cannot be obtained within the parameters of the weld schedule.	Incorporated

Supplement Number	Date	Description	Supplement Status
R-3825-5 Vol I-49	4 September 1974	Adds bypass duct test plate kit 9016701-11 and hot-gas exhaust test plate kit 9016710-11.	Replaced by Supplement R-3825-5 Vol I-50
R-3825-5 Vol I-50	30 September 1974	Corrected nut part numbers and changed attaching hardware in test plate kit 9025400-11.	Incorporated